INTERNATIONAL:

FISCAL POLICIES TO CONTROL POLLUTION: INTERNATIONAL EXPERIENCE

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ABSTRACT

Over the past few decades, the environmental policy debate has evolved to recognize the utility of influencing pollution abatement by using market forces that integrate economic and environmental decision-making. Market-based incentive (MBI) instruments may be broadly classified to include environmental taxes, investment tax incentives, tradeable permits, user charges and deposit refund systems. Investment tax credits have been the preferred fiscal instruments for pollution control because they seem to balance environmental considerations with concerns about industrial competitiveness. Their use, however, may not have the desired effect of reducing pollution and may, in certain circumstances, increase emissions levels. The taxes are also sometimes seen as subsidies in disguise. This report is a comparative analysis of the fiscal instruments used by countries in Asia, Europe and North America, whose design philosophy explicitly incorporates an environmental agenda. In particular, it discusses the intent and design of investment tax incentives, presenting a review of the basic theoretical framework necessary for understanding how they function. In addition, it outlines a set of criteria that may be used to evaluate their economic and environmental impact and describes possible legislative and structural revisions that may enhance their effectiveness and promote their efficiency.

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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. Market-based incentive instruments can be broadly classified to include a combination of environmental taxes, investment tax incentives, tradeable permits, user charges and deposit-refund systems.

The level of interest in using MBIs to reduce environmental damage has increased greatly in recent years. An MBI affects the estimates of costs and benefits of alter-

native actions, hence influencing the decisions and behaviour of individuals, firms and governments, so that environmentally superior alternatives are chosen. In short, MBIs use market forces to integrate economic and environmental decision-making.

The use of MBIs saves economic resources because decision-makers are made aware, through prices, of the environmental implications of their choices.

Fiscal instruments for environmental protection are a subset of MBI mechanisms. Though not always in conformance with ideal market-incentive approaches, a wide variety of pure fiscal (or tax) incentives may be used to influence pollution abatement. The structure of income taxes, including tax rates, the definition of the tax base, the relation between corporate and personal taxes and loss treatment provisions, can affect pollution control. In the case of indirect taxes, differential tax rates on products or inputs may have the effect of influencing pollution, e.g. higher excises on oil products may cause more polluting coal to be used.

This report is focused on those fiscal instruments for environmental protection whose design philosophy explicitly incorporates an environmental agenda. A limited, but comprehensive, list would contain:

- 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.

This study discusses the intent and design of investment tax incentives, and their economic and environmental impact. It is organized as follows:

Section I provides a taxonomy of investment tax incentives for pollution control used by selected industrialized countries in Asia, Europe and North America. Section II reviews the theory of tax incentive instruments. The purpose is to create a framework for identifying structural weaknesses and negative behavioural influences. Section III introduces the criteria that may be used to evaluate tax incentives and uses a comparative methodology to suggest structural and legislative modifications of tax incentives that may enhance their effectiveness and promote efficiency.

I. TAXONOMY OF INVESTMENT TAX INCENTIVES FOR POLLUTION CONTROL

Possible incentives that can be extended through the tax system are differentiated by the nature of the base for tax benefit determination; 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 the industrialized nations of Asia, Europe and North America. In particular, the incentive tax laws of the following countries have been examined: Japan, Korea, Singapore, Taiwan, France, Germany, the Netherlands, the United Kingdom, Canada and the United States.

While there are important differences in accounting and tax benefit accrual, a general list of the specific incentives encountered are: accelerated depreciation, investment tax credits, partial expensing and tax exemptions/deferrals.

Table 1 summarizes the basic structure of investment tax incentives for pollution control in these nations.

A. *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 (CTL), 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 CTL.

1. 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.[1] 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.[2] 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.[3]

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 70 metres high, etc., have varying useful life spans, ranging from 10 to 30 years.[4]

2. 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 recomput-

1. Report of Ministry of Finance Committee on Business Accounting Principles, as amended, 30 August 1974, Note 17.
2. CTL Arts. 31 and 32.
3. CTL Basic Circular Sec. 7-5-1.
4. Tables 6 and 7, *Ministerial Ordinance Concerning the Useful Life of Depreciable Assets*, Ministry of Finance Ordinance No. 15, 31 March 1965, as last amended by Ordinance No. 17, 31 March 1990.

TABLE 1

COUNTRY	TYPE OF INCENTIVE	DETAILS
JAPAN	Special Depreciation (Expensing) for pollution control equipment. No Investment Tax Credit.	25% initial allowance is permitted. The remainder of investment cost is depreciated normally.
KOREA	Investment Tax Credit for pollution control equipment. Accelerated Depreciation or Investment Credit, for new technologies.	3% for imported equipment. 10% for domestic equipment. 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. Investment Tax Credits.	Depreciation over half of the life of the assets. 5% to 20% depending on the type of asset.
FRANCE	Accelerated Depreciation for pollution control equipment. Regional tax concessions and grants are available.	50% initial allowance, remainder at 10 to 20% straight-line.
GERMANY	Accelerated Depreciation. No Investment Tax Credit.	60% initial allowance, rest at 10% until full amortization.
NETHERLANDS	Investment Tax Credit for any environmental protection investment. Grants and Loans to assist research and development projects.	3% to 15% depending on the type of asset.
UNITED KINGDOM	No special incentives for installing pollution control equipment.	
CANADA	Accelerated Depreciation for pollution control investments on plants commissioned before 1974. Investment Credits for certain activities which can include expenditures on pollution control assets.	3-year straight-line 25%—50%—25% vs. normal declining balance depreciation, 20% to 25%. Depends on taxpayer, activity, region and year involved.
UNITED STATES	No special incentives for installing pollution control equipment.	

ed based on the shorter life, and the excess of depreciation (as computed over the depreciation actually deducted during those years) may be currently expensed.

3. Special accelerated (initial) depreciation[5]

Under the "special initial depreciation" method, 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:[6]

- qualified facilities to prevent pollution: 25 percent of acquisition cost,
- qualified plants equipped with special anti-pollution devices and qualified energy-efficient plants: 18 percent of acquisition cost, and
- 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.

The above 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 which 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:

5. Law No. 26, 31 March 1957, as last amended by Law No. 15, 31 March 1990. Cabinet Order No. 43, 31 March 1957, as last amended by Cabinet Order No. 93, 31 March 1990.
6. Special Tax Measures Law (STML) Art. 43.

- carry losses over five years and back one,
- establish certain special tax incentive reserve accounts and take certain tax incentive deductions and credits, and
- use accelerated depreciation or initial depreciation with respect to certain assets.

B. *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)[7] provides tax incentives and regulates those specified in 22 other statutes, such as the Income Tax Law, the Value-Added Tax Law, the Local Tax Law and the CTL itself. There are two provisions within the TERCL which directly and indirectly provide incentives for pollution control.

There is a direct investment tax credit of three percent (or ten 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:[8]

- facilities for increasing productivity,
- energy-saving facilities,
- anti-pollution facilities,
- facilities for preventing industrial hazards, and
- other specified facilities.

More indirectly, there is a choice between accelerated depreciation and investment credits for persons who start a business using new technology patented in Korea or developed by institutions designated through consultations between the Ministry of Finance and the Ministry of Science and Technology.[9] Investors have a choice between:

- an investment credit at the rate of three percent (or ten percent in the case of machinery made in Korea) of the value of the investment in new assets, or
- taking 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 CTL:[10] (i) the straight-line method, (ii) the declining-balance method and (iii) 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.

C. *Singapore*

While providing a number of incentives for certain explicitly favoured 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.[11]

To facilitate the absorption of depreciation allowances, unused allowances may be carried forward indefinitely or set off against future profits.[12] In the case of companies, the same continuity-of-ownership test applicable for losses must be met in order to carry over depreciation allowances.[13] 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.[14]

D. *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).[15]

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.

1. Accelerated depreciation

Under the earlier SEI, investments in pollution control equipment could be depreciated over a period of two years (straight line).[16] The present SUI 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 (ITL). 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.[17]

7. Law No. 1723 of 1965.
8. TERCL Arts. 71 and 18(1).
9. TERCL Art. 18 and TERCL-Executive Decree, Art. 15.
10. CTL Art. 56.
11. The Income Tax Act (ITA) Art. 19A.
12. ITA (Cap. 134) Sec. 23(1).
13. *Id.*, Sec. 23(3).
14. *Id.*, Sec. 23(2A).
15. Statute for Upgrading Industry (SUI), promulgated on 29 December 1990, by Presidential Decree. It is effective from 1 January 1991 until 30 June 1998.
16. 1990 ITL Art. 51.
17. *Taxation in the Republic of China*, Ministry of Finance (1991).

If the residual period after depreciation is less than one year, it is not counted, i.e. full depreciation will be completed in the earlier period.[18]

2. Investment tax credit

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 NTS 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, and
- 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.

3. 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.

4. 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 ten percent profit-seeking enterprise income tax if the funds are used for certain specified purposes.[19] Such purposes include:

- purchasing various classes of products, including pollution control equipment,
- repaying loans borrowed for the purpose of purchasing the aforesaid equipment, and
- investing in certain important industries specified by the government.[20]

According to the ITL, if the accumulated retained profits of a company exceed one 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.[21] 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 ten percent profit-seeking enterprise income tax on each shareholder for the current taxable year.[22]

5. 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 4 above), 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.[23]

E. *France*

The general guidelines concerning tax incentives are contained in the Code général des impôts (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.

F. *Germany*

The German Income Tax Law, Einkommensteuergesetz (EStG), provides accelerated depreciation or initial expensing provisions for assets used for pollution control.

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18. SUI Art. 5.
19. 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, and
    - other items permitted by the Ministry of Finance.

    International Bureau of Fiscal Documentation, *Taxation in Asia and the Pacific, Taiwan*: Supplement No. 81 (May 1991).
20. The list of eligible products and designated industries are specified by the Executive Yuan, with a revision option every two years.
21. ITA Art. 76-1.
22. ITL Art. 88.
23. SUI Art. 16.

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.[24] 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.[25]

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 that which serves 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 31 December 1991.[26]

There are no investment tax credits in Germany.

G. *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 so-called "investments for implementing environmental policies".[27]

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 which have the effect of reducing or eliminating pollution.[28]

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.[29]

H. *The United Kingdom*

There are no investment incentives for installing pollution control equipment in production facilities in the United Kingdom. The only anti-pollution expenditure that is eligible for a deduction is the cost incurred when closing down an oilfield (or part of a field) in order to minimize the environmental impact. This deduction is allowable only against a capital gains tax liability.[30]

The UK tax code is fairly generous as regards tax incentives for the research and development (R&D) of pollution control technologies and equipment. In order to support research in environmental protection products and technologies, the following two provisions have been made available:

1. 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.

2. 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.[31]

I. *Canada*

Incentives within the income tax system generally reduce both the provincial and federal taxes payable. Ontario, Quebec and Alberta, the three provinces which 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 CCAs 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 (ITA), 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

24. EStG. Sec. 7(2).
25. EStG. Sec. 7(d).
26. EStG., as repromulgated 7 September 1990; see Bundesgesetzblatt I (BGBL., Official Law Gazette of the Federal Republic of Germany), at 1898, Sec. 7d.
27. International Bureau of Fiscal Documentation, *The Taxation of Companies in Europe, Netherlands* – 53, Corporate Income Tax, Supplement No. 95 (February 1991).
28. Price Waterhouse, *Doing Business in the Netherlands* (December 1990), at 32.
29. *Supra*, note 27.
30. Oil Taxation Act, Chapter 22, Art. 3, 1975.
31. Capital Allowances Act, Chapter 1, Arts. 137 and 138, 1990.

apply to the Minister of Environment for approval to depreciate this property at an accelerated rate.[32] 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), and
- operations carried on through the employment of movable equipment in Canada prior to 1974. (The ITA 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 ITA does not contain comparable provisions for post-1973 operations. Thus, the class of taxpayers who are eligible to benefit from the programme 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 Canada's CCA system. In both of these cases, properties acquired after 12 November 1981 may be depreciated by claiming a maximum CCA 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 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 investment tax credits 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.

J. *The United States*

Pollution control investments are not accorded special incentives under the US 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 31 December 1986 is recovered over a 3, 5, 7, 10, 15 or 20-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.

II. AN 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 classes. Most common of these 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.

A. *Background*

Investment tax incentives are specific tax preferences directed towards 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. However, 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.

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

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 on the budget.

B. *The environmental impact of investment incentives for pollution control*

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 (i.e. manufacture or production of goods and services).

Entities invest in pollution control assets only because they are required to do so by law, i.e. environmental regulation. Pollution control equipment represent non-productive assets since they do 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.

In this case, 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, i.e. 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.

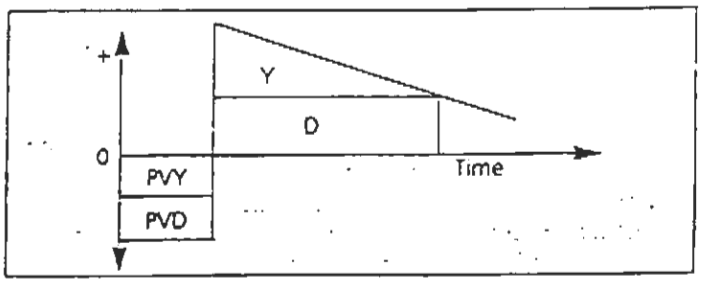
There is no incentive to reduce pollution, but neither is there an incentive to pollute more. The investment incentive reduces the marginal cost of abatement without permitting any marginal increase in pollution.

C. *Neutrality of investment tax incentives*

Since tax incentives influence behaviour, 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 behavioural 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.[33] ("Covered" investments refer to those which 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 following figure provides a graphical representation of an investment profile.



The gross-of-depreciation income stream is also equal to the market price of the asset.

33. Arnold C. Harberger, "Tax Neutrality in Investment Incentives", from *The Economics of Taxation*, Henry Aaron and Michael Boskin eds., The Brookings Institution, Studies of Government Finance (1980), at 299.

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.

1. 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, materials, etc., are deducted currently, i.e. 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.

(a) *Impact on 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 lo from the Treasury to the firm. This reduces the costs financing and acquiring new capital, hence improving firm's cash flow. The characterization of deferred tax as merely equivalent to an interest-free loan overloo some of their other advantages. These are best expresse in a statement by Richard Bird,[34] "Who would refuse a interest-free loan available without any strings at a without having to ask anyone for it, without having to p up any security, and without even having to pay it bac unless profits are made in the future?"
- The faster recovery of investment costs reduces recove risks in the long run.

(b) *Distortions generated by accelerated depreciation*

Accelerated depreciation changes the ranking of projec depending upon the useful life of the assets. The princip distortion is that accelerated depreciation is more attractive t investors in long-lived assets. The gain from early deductior are larger because the postponed tax payments can b delayed for a longer period when the asset has a longer life.

For example, consider an asset that has a 20-year life an another with a 5-year life. In both cases, depreciation is pe mitted over two years. For an investor holding the 20-yea asset, the reduction in tax liability that occurs in the first tw years is recovered in nominal value over 18 years, whereas for a 5-year asset it is recovered over the following thre years of the asset's life. Consequently, it is evident that 2(year assets will be preferred over shorter-lived assets.

In the case of pollution control investments, this could influence the choice of technologies selected for a particula abatement task. Countries where marked preferences fo long-lived assets could exist are Singapore (all assets depre ciated in three years), and Germany (60 percent initia expense allowed).

(c) *Neutral depreciation*

A neutral depreciation allowance is one where assets with th same present value of net income streams carry an equal ta burden. This will be achieved if the net income stream being taxed each year is equal to the gross income flow less th actual diminution in asset value. This is the case where ta 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 th 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. Capital assets do not wear out evenly, which makes it difficult to predict their actual reduction in value (economic depreciation). Further, equipment often becomes obsolete (i.e. depreciates economi-

34. Richard M. Bird, *Tax Incentives for Investment: The State of the Art*. The Canadian Tax Foundation, Canadian Tax Paper No. 64 (November 1980), at 19

TABLE 2

COMPARISON OF TWO INVESTMENT PROJECTS: Depreciation over half the normal life

	YEAR 0	1	2	3	4	5	6
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
Internal rate of return:		social, 17.2%; private, 9.8%					
Net present value:		private NPV at 10% is −3.6					

	YEAR 0	1	2	3	...	20	21	...	40
PRIVATELY ACCEPTABLE									
Gross-of-tax cash flow	−1200	205	205	205	...	205	205	...	205
Depreciation	0	60	60	60	...	60	0	...	0
Taxable income	0	145	145	145	...	145	205	...	205
Tax at 50%	0	−73	−73	−73	...	−73	−103	...	−103
Private cash flow	−1200	133	133	133	...	133	103	...	103
Internal rate of return:		social, 17%; private, 10.5%							
Net present value:		private NPV at 10% is 55.5							

cally) before it has been completely worn down (i.e. depreciates physically).

(d) *Typical cases of non-neutral accelerated depreciation*

Most accelerated depreciation mechanisms are non-neutral. Though this might seem to be a rather sweeping statement, after having shown how difficult it is to measure economic depreciation, this should not be surprising. There exist certain mechanisms 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:

Case 1. Depreciating assets in a specified number of years, regardless of their true economic life.

Case 2. Allowing assets of different economic depreciation patterns to be depreciated according to a specified method (e.g. exponentially).

Case 3. Depreciating assets in a specified fraction of time (e.g. twice as fast as dictated by true economic depreciation).

The accelerated depreciation provisions of the Taiwanese Statute for Upgrading Industry is a variation of case 3 above. In Taiwan, depreciation for certain specified assets, including pollution control equipment 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.[35]

Nonetheless, it is still possible to find examples that violate the criterion of neutrality. For illustration, we take a pair of projects with 6-year and 40-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 ten-percent private after-tax discount rate.

The project with a 6-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 40-year lifetime will be accepted privately, despite the fact that its social rate of return is 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 percent being rejected and the project with the lower social return being accepted.

(e) *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.

35. *Supra* note 33, at 303-304.

(i) *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.[36] 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, there is a bill pending in the Netherlands to have such a law adopted.

(ii) *Partial expensing with economic depreciation of the remainder*

This scheme is also called Harberger-Bradford neutrality. Under the scheme, 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, i.e. ordinary depreciation in 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.

2. Investment tax credit

The investment 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 foregone.[37]

The Netherlands is an example of a country where the superiority of investment tax credits over accelerated depreciation has been recognized. This is evident from the fact that accelerated depreciation and other tax allowances in the previo code were replaced with investment tax credits.

Uniformly applicable investment tax credits are in son ways fiscal substitutes for investment stimulants that shou normally be accomplished through monetary policy. Howe er, monetary stimulants may not always result in busine investment. The argument might, therefore, be made favour of directed investment tax incentives.[38]

In most cases, the tax credit is given as a percentage of t purchase price of the assets. Credits are not usually refun able, i.e. they can be claimed only against a positive tax li bility. To facilitate a more equitable treatment of those wi and without taxable profits, credit carry-over and transf schemes may be provided. Canada, for example, has exper mented with refundable R&D credits.

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

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

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

(a) *Distortions created by investment tax credits*

The investment tax credit works in favour of short-live assets. This is in contrast to accelerated depreciation, whic favours the long-term fixed investment.

A simple exercise using government bonds as illustratio gives a striking example of why tax credits perpetuate thi bias. Assume that a government passed a law granting a subsidy of seven percent of the purchase price to everybody buying a newly issued government obligation. Suppose that the available government obligations were perpetuities, 20-yea bonds, 1-year bonds and 90-day bonds.

If the interest rate were one percent per month, the bonds would have a yield of ten percent every 90 days. As a resul

36. Richard Musgrave, *The Theory of Public Finance: A Study in Public Economy* (New York: McGraw Hill, 1959), at 343.
37. Testimony by Eisner and Jorgenson in the US Senate Report, *Joint Seminars Encouraging Capital Formation Through the Tax Code* (Washington, D.C.: US Government Printing Office, 1975).
38. Martin Feldstein, "Inflation, Capital Taxation, and Monetary Policy", in Robert E. Hall, ed. *Inflation: Causes and Effects* (Chicago: University of Chicago Press, 1982), at 153-67.

TABLE 3

COMPARISON OF TWO INVESTMENT PROJECTS: Each with 30% tax credit

	YEAR 0	1	2	3	4
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	
Internal rate of return:	social, −5%; private, 17%				
Net present value:	private NPV at 10% is 131				

	YEAR 0	1	2	3	...	infinity
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
Internal rate of return:	social, 9%; private, 6.4%					
Net present value:	private NPV at 10% is −375					

of the tax credit, everybody would rush to buy 90-day bonds. No one would buy 1-year bonds, let alone perpetuities, since a subsidy on the purchase price of an asset is biased in favour 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, i.e. having a gross-of-tax return below a socially acceptable hurdle rate, but having a privately acceptable net-of-tax return would be favoured over one whose social rate of return is acceptable.

An illustration of socially sub-optimal 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 high 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.

(b) *Neutral investment tax credits*

An investment tax credit subsidizes the purchase price of an asset. At the beginning of our discussion of investment incentives, it was shown that the purchase price or value of the asset is equal to PVY+PVD, i.e. 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(PVY+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, i.e. 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.[39] 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*

39. From a talk by Arnold C. Harberger, *Tax Incentives in a Capital Theory Context*, at the Latin American Meetings of the Econometric Society, San Jose, Costa Rica (August 1988).
The original idea is attributed to Cary Brown.

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.

III. EVALUATION OF INVESTMENT TAX INCENTIVES FOR POLLUTION CONTROL

Part B of this section analyses the criteria of cost effectiveness and efficiency used to evaluate MBI instruments. These two criteria are by no means exclusive or comprehensive. However, informed policy-making requires that they be dominant. To provide a wider perspective and enhance the scope of the analysis, some of the criticisms directed at tax incentives for pollution control are discussed in Part A. Part C examines certain structural issues of tax incentive design and legislation that can enhance the effectiveness and efficiency of tax incentive instruments for pollution abatement.

A. *Criticisms of investment tax incentives for pollution control*

Even though tax incentives do influence behaviour, there is criticism concerning their inclusion in the family of MBIs. Investment tax incentives do not conform to the tenet of influencing environmentally superior choices that is mandated by an inflexible and exacting definition of MBIs. These incentives have sometimes been termed "pseudo-incentives".[40] Quoting directly:

> 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.[41]

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:

- 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.
- 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 contribut such a subsidy greater than the cost of providing the incentive.

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

B. *Criteria to evaluate investment tax incentives*

If tax incentives are broadly applicable to all investmen their evaluation is greatly simplified. The advantage of a ge eralized evaluation model that treats all investments simil ly (i.e. assuming that tax incentives are available to all clas es of assets) is that no distinctions need to be made regardi the physical characteristics of the investment project. Ho ever, incentives for pollution control investments by defin tion target a selective class of assets. Consequently, they c not directly lend themselves to such a general analysis.

In order to proceed with a meaningful evaluation, the follo ing words of caution are in order:

Focus on intra-industry investment distortions

Narrowly defined investment incentives are aimed at indu ing investments in certain technologies and industry group i.e. certain sectors are preferred over others. In a pure ec nomic sense, most narrowly defined incentives create disto tions, since alternate investment choices are being influenc by the tax system. It is only in cases where an externality being offset that an investment incentive would correct for distortion. With incentives being available for certain explic itly stated activities, it is evident that tax policy is being us as an instrument to meet other policy objectives.

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

Presence of perverse incentives

Perverse incentives in the context of environmental protectio refer to situations where the tax factor results in investme decisions that are incrementally more polluting. In most of th countries surveyed, incentives for pollution control are avai able principally for equipment purchases. This creates a bia against the adoption of cleaner production processes that min imize the need for pollution control equipment. Thus, despit encouraging the installation of control equipment to achiev an aggregate reduction in pollution levels, the same incentive could act as a barrier to long-term emission reductions.

40. Theodore Panayotou, *Economic Incentives in Environmental Manageme and their Relevance to Developing Countries* (Paris: OECD, 1991), at 96-97.
41. *Id.*

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 towards 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.

1. 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 these 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 from the economic costs of raising tax revenues and/or borrowing to compensate for the foregone revenue.

Benefits include the value attributed to improved environmental quality. Since pollution control requirements are perceived as having negative impacts on industrial competitiveness and other macroeconomic indicators, improvements in these variables may also be included.

To facilitate an accurate comparison, however, all costs and benefits should be attributed to the specific investment tax incentives for pollution control. In practice this may be difficult. Direct costs are easy to estimate because they are equal to the investment expenditures undertaken. On the other hand, the direct benefits and the indirect effects from improved environmental quality are more difficult to determine. First, the benefits are often intangible, necessitating the use of various techniques designed to assign monetary values to environmental quality. Second, measurements of the economic impact on other sectors require simplifying assumptions that may make the analytic reasoning rather tenuous. Third, the data required may be unavailable, and even if available it may be not be accurate enough to draw useful policy conclusions.

Three classes of benefits have the related measurement problems explained below.

(a) *Measuring marginal improvements in environmental quality*

Emission reductions may be a result of the prescribed standards and regulations laid down by the environmental protection agency and may not be a direct consequence of the tax incentives provided.

For a tax incentive to cause incremental pollution reduction beyond levels mandated by regulation, there would have to be firms investing in "excessive" pollution control equipment.[42] For this to be true, the present value of the tax incentive on the investment would have to be higher than the present value of the expenditure on equipment. This seems unlikely for two reasons:

- Pollution control investments do not generate any income for the enterprise since no firm is likely to invest in facilities whose marginal financial cost will be above the marginal tax benefit, unless legally required to. In order for pollution control investments in excess of the legal requirements to be attractive, the incentive would have to provide a subsidy in excess of, or at least equal to, the equipment cost.
- There is no non-financial incentive for the firm to internalize the costs of environmental degradation that are legally external to it.

(b) *Measuring directly attributable improvements in the terms of trade*

Investment incentives for pollution control are at times justified 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.

In one study that used a partial equilibrium framework to measure the impact of marginal changes in industrial pollution abatement costs on the US balance of trade in general, and its balance of trade with Canada in particular, the following conclusions were reached:[43]

- 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 programmes have changed the US 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.[44]

(c) *Measuring improvements in economic growth rates*

Investment incentives have also been rationalized as necessary for reducing the impact of environmental regulation and

42. The word "excessive" is used because such behaviour runs counter to rational profit-maximization.
43. H. David Robinson, *Industrial Pollution Abatement: The Impact on Balance of Trade*, Canadian Economics Association (1988), at 187-199.
44. US General Accounting Office, *A Market Approach to Air Pollution Control Could Reduce Compliance Costs Without Jeopardizing Clean Air Goals* (1982).

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.[45] In an effort to determine the impact of non-productive pollution control investments, models have been developed that were designed to plot the transition path of the US 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.[46]

Though these numbers seem to indicate substantial economic opportunities foregone as a consequence of the costs of pollution control, the real issue is whether the growth in income and consumption would be consistent with environmental protection.

2. 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 which 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.[47]

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" investment with low rates of social yield, while failing to induce other "covered" investments with higher rates of social yield.[48] ("Covered" investments refer to those which are eligible for the tax preference under the tax code.)

To illustrate further, let us consider a preferred group of assets, i.e. 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 ten 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-of-tax yields that are less than that level. Making the incentive more generous would admit all investments w gross-of-tax yields of, say 15 percent or more, but none w yields of less than 15 percent. For each level of stimulus, ne trality requires some rate of social return that will tend encourage all independent investment projects meeting t rate to be privately accepted, while discouraging the priv acceptance of projects failing to meet it.

Tax incentives that affect the net-of-tax return for all inve ments at an *equal rate* have the property of reducing the cr ical level of expected marginal productivity in a very orde manner. Under such an incentive regime, it would be possi for the government to have a normal tax administration which the gross-of-tax rate of return was 20 percent p annum, a "preferred" category in which this rate was 16 p cent per year, and a "super-preferred" category in which t cut-off rate was 10 percent per annum.

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

3. Policy implications of the evaluative criteria

The ability to justify the use of an investment incentive f pollution control equipment on the basis of these evaluati criteria suffers from three major problems.

First, there is an implicit divergence from the polluter-pay principle, which is fast becoming a dominant determinant using economic instruments. While there are political re sons for providing a hidden tax expenditure subsidy throug a general tax incentive rather than an outright cash subsic the fundamental issue is that polluting activities are beir subsidized without affecting pollutant levels.

More specifically, the use of investment incentives indicat a lack of focus on the broader issues of environmental pr tection. Allowing deductions for environmental expenses i the absence of a policy agenda to deal with specific enviro mental problems is much like trying to fit a square peg into round hole.[49]

Second, focusing on the measurement of tax incentive effe tiveness and efficiency actually distracts attention from th central task of determining the socially optimal level of po lution reduction. The use of an investment incentive amoun

45. Dale Jorgenson and Peter Wilcoxen, "Impact of Environmental Legislatic on US Economic Growth: Investment, and Capital Costs", from *US Enviro mental Policy and Economic Growth: How do we Fare?*, monograph by th American Council for Capital Formation Center for Policy Research, Washin ton D.C. (March 1992), at 13.
46. *Id.*, at 16-19.
47. Dan Usher, "The Economics of Tax Incentives to Encourage Investment Less Developed Countries", *Journal of Development Economics* (June 1977), 117.
48. *Supra* note 33, at 299.
49. Robin J. Macknight, *Square Pegs and Round Holes: Environmental Co Under the Income Tax Act*, Canadian Tax Foundation, Conference Report 199 at 10:2.

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 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 favoured by government subsidies.[50] This was found to be the case for subsidized sectors like mining and primary metals processing.

Finally, 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.

C. *Improving the effectiveness and efficiency of investment incentives*

The criteria outlined in Part B may be used to determine the weaknesses and other inconsistencies of investment tax incentives. Though the incentives may be appropriate for promoting non-pollution-related objectives, their relevance to pollution abatement and control is gradually diminishing. As noted earlier, tax incentives for pollution control equipment achieve multiple policy objectives, and therefore 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 returns in Japan.
- Differentiation based on the type of technology, i.e. 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 sub-section analyses a few mechanisms and structural aspects of tax incentive design that could enhance their efficacy. A comparative perspective is used wherever possible.

1. 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 (i.e. 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 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 emission 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 Section I for a description of the Canadian accelerated depreciation allowances).

2. Impact on new investments

There is a notion that new investments do not really stand to gain from a variety of tax incentives. There is a very large tax benefit to existing (or older) facilities that have positive cash flows when they claim deductions or credits on new investments on pollution control equipment. These benefits on new investments are not attractive incentives for those investors who expect to suffer 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 all the investment incentives offered. A barrier to innovation is introduced as a result of favouring owners of old capital over new entrepreneurs.

To make investment tax credits and capital cost allowances equally attractive to new enterprises who 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, and 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 investments.

50. Brian Hull and Antoine St-Pierre, *The Market and the Environment*, The Conference Board of Canada, Ottawa (1990), at 19.

Second, from a government perspective, granting an incentive whose benefits cannot be fully realized will decrease the level of tax expenditure items on 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.

(a) *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.

(b) *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 investments.

If the investing entity were allowed to sell or transfer its unused tax preferences to another entity that was able to use the deductions/credits currently, it stands to gain the full value of 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 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 efficient transfer of unused preferences between the entity issuing the flow-through shares and the investor who can use the tax preferences, 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 foregone by the government in offering the tax preference, the enterprise received approximately 40 cents, owing to inefficiencies in the flow-through arrangement's transfer of the unused preferences.[51]

An example of a system whereby tax preferences could be sold to other non-related 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 harbour" scheme, and operated through a leasing arrangement.[52] Firms without taxable income could sell their depreciation allowances and investment tax credits to corporations with taxable income.

3. *Providing incentives for pollution control research*

To further the objective of environmental protection, some countries have decided to provide incentives for R&D in this 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. We will now briefly outline the issues and problems concerning tax incentives for R&D.

Innovative activities in the R&D of pollution control equipment entail financial risks for the parent entity. Funds diverted towards 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 ground 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.

There is a belief that private firms would carry out insufficient 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. R&D incentives have been the topic of intense policy and legislative debate.

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. 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 non-exclusive public good available to everybody. Tax incentives merely subsidize the cost of private research, thereby reducing the final public benefit of the expenditure.

However, the legislative problems with R&D tax incentives are of greater direct concern. Most of these problems lie in the definition of what constitutes R&D 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 relations or technologies.

51. Glenn P. Jenkins, "Tax Shelter Finance: How Efficient Is It?", in *Policy Options for the Treatment of Tax Losses in Canada*, The Clarkson Gordon Foundation (1991), at 7:3-7:41.
52. Provisions of the Economic Recovery Tax Act (ERTA) of 1981, Public Law No. 97-34, 95 Stat. 172 (1981), US Internal Revenue Code.

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

4. 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.

Arguments against providing a means of matching anticipated future costs with current year income and profits are that future costs are unascertainable because they are contingent.[53]

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:

(i) 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.

(ii) If such a liability can be viewed as an expense, was it incurred "for the purpose of gaining or producing income"?

(iii) 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.)

5. 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.[54] The implication is that large firms may absorb incentive benefits more completely and thus become still larger.[55] 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, i.e. ring-fencing of investment activities. The more progressive approach would provide some appropriate means for the complete utilization of tax preferences.

6. 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.[56] "Pollution control technology" includes any patent rights or technological know-how that is required to be used in conjunction with the equipment mentioned above.[57]

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 homogenous and have only a single use (i.e. 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 non-pollution 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 may, however, also be used to remove solid debris from entering the plant's cooling system or other auxiliaries. This constitutes a

53. *Supra* note 49, at 10:3.
54. *Supra* note 34, at 52.
55. Eric W. Kierans, *Contribution of the Tax System to Canada's Unemployment and Ownership Problems*, Canadian Perspectives in Economics (Toronto: Collier-Macmillan Inc., 1972).
56. International Bureau of Fiscal Documentation, *Taxation and Investment in Asia and the Pacific*, Supplement No. 87 (November 1991), at 58a.
57. *Id.*

non-pollution 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 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 anti-pollution machinery and equipment for which tax preferences are allowed include the following:[58]

(1) equipment for the disposal of waste oil from ships (including oil separators, incinerators, and other accessories),
(2) desulphurization equipment (including hydrogenating desulphurizers of hydrocarbon oil, etc),
(3) sewage treatment systems (including attachments to equipment or structures such as conveyors, measuring instruments, automatic regulators, etc.),
(4) smoke treatment facilities (including ventilators, heat exchangers, transformers, etc.),
(5) malodorous substance treatment systems (including exhaust pipes, gas coolers, dust collectors, air compressors, etc.),
(6) noise control systems (including silencers, sound arresters, forging machines, etc.), and
(7) industrial waste disposal facilities (including incinerators, devices to make hydrocarbon oil form waste plastics, etc.).

There are no fixed formulae 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.

IV. CONCLUSION

Tax incentives designed to promote investments in pollution control equipment have been the dominant form of fiscal instrument to combat pollution used by countries worldwide. As we have shown, these incentives may or may not assist in the long-run improvement of environmental quality. Furthermore, 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 those that are both economically and environmentally inefficient. 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.

58. Notification No. 69, Table 1, 29 May 1973; Sangyo to Kogai (Industry and Pollution).

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Next month we will feature Part II of this article, which looks at alternative market-based instruments for pollution control.