A REVIEW OF MARKET BASED INSTRUMENTS FOR POLLUTION CONTROL : IMPLICATIONS FOR INDIA

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No. 2 March 1997

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Prepared as a background paper for the Taskforce Report of the Ministry of Environment and Forest, Government of India. The paper reviews the different market based instruments for industrial pollution control that have been used in developed and developing countries. Some of the applications are highlighted to analyze the effectiveness of the instruments and their policy implications for India.

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1. Introduction

Environmental pollution problems arise due to the absence or inadequate pricing of the environment. For instance, when common property resources, like air and water, are considered free for dumping wastes. These activities result in negative externality effects that impose harmful effects/costs on people other than the polluters. Environmental pollution can be viewed as a by-product of production and consumption activities of both the industry and the household. To each agent, the marginal benefit of emitting pollutants into the free common property resource outweighs the marginal cost that has to be borne from the degradation of the environment (since the negative effects are distributed across the society). Thus the resulting pollution is greater than what is socially desirable, and in some cases when the level of pollution crosses a threshold value (that is, beyond the buffering capacity of the environment) the pristine environment can be lost forever.

The existing market system fails to correct for the distortions, since there is no incentive for polluters to internalize the external costs into their production or consumption decisions. To correct for the externality problem, two broad types of policy options are available: command and control measures (CAC), and economic/ market-based instruments (MBIs). While both the options can alter individual behaviour to abate environmental pollution and reach a socially desirable outcome, the second set of instruments are more efficient. The CAC measures consist of mandatory standards and norms on environmental quality that are imposed by the regulatory authorities. The MBIs may take the form of taxes/ charges/ subsidies in the existing free markets, or establish prices of pollutants through tradeable pollution permits, or provide economic incentives through environmental education and information.

The choice of the appropriate MBI and its effectiveness depends on several factors including the information available (on abatement costs and benefits), the institutional structure of the economy, the number of polluters involved, the type of pollution addressed, etc. A large number of countries have been practising with the economic instruments with varying degrees of success. Thus an analysis of these applications across countries will provide a valuable insight on the choice of the appropriate instrument for an economy planning to adopt economic measures in pollution control.

India has so long maintained a regulatory regime which has been found ineffective, and the level of pollution has been on the rise. More recently, the focus has shifted towards the adoption of MBIs to address the pressing pollution problems. In February 1992, the Policy Statement for Abatement of Pollution issued by the Government of India stated an aim of providing industries and consumers clear signals about the cost of using environmental and natural

resources, since there was an increasing trend in environmental pollution[1]. This paper aims to provide a comprehensive review of the experience of both developed and developing countries with MBIs in industrial pollution control, in order to identify some of the economic instruments which could be better suited to Indian conditions. The review includes taxes/ fees which have a function in abating environmental pollution from industrial sources (also domestic sources and vehicles to some extent), even though they may have been introduced for revenue purposes only by the government.

In all the countries it is observed that MBIs complement the regulatory command-and control policies. Thus, in general, the regimes are mixed, and not made purely of economic measures: like charge-cum-standard, or permit-cum-standard, where mandatory environmental norms accompany the pollution charges and permits respectively. The discussion here is arranged as follows: section 2 defines the eight types of MBIs; section 3 highlights the advantages of market-based instruments over command and control measures, the choice between MBIs, and briefly touches upon the equity issue and revenue aspect of MBIs; section 4 analyses the effectiveness of various MBIs in practice from the experience of developed and developing countries; and section 5 concludes with the policy lessons for India. The more detailed country information is provided in the tables at the end of the paper.

2.1 Types of economic instruments

The different types of MBIs considered here follow the taxonomy in Eskeland and Jimenez (1992), where the economic instruments were categorized into two groups:
(A) direct market-based instruments, and (B) indirect market-based instruments.
Eskeland and Jimenez classified emission/ effluent charges, tradeable permits and deposit-refund schemes as the direct tools; and input/output taxes, and subsidies for substitutes and abatement inputs as the indirect tools. Here the set of indirect market based tools has been augmented by including user/ administrative fees, enforcement incentives, and suasive instruments, since they too provide economic incentives in pollution control.

2.2 *(A) Direct market based instruments*

The direct instruments are applied on the pollutants (the pollutant is thus metered under such policies), hence the linkage and impact of the policy on environmental quality is easy to define. Three such direct tools include:

1) *Emission/ effluent charges:* These are fees/ taxes levied by the authority based on the quantity and/or quality of pollutants discharged into the environment. The optimal (Pigouvian) pollution

[1] Mehta, et al. (1994), pp. vii, 52-53.

tax should be set equal to the marginal social damage cost of the emission/ effluent (at the optimal outcome). These charges alter relative prices in the existing markets and encourage pollution abatement. However, polluters can shift the pollution from one environmental medium to another (say, from air to water/ groundwater) if the authority focuses only on one medium.

2) *Tradeable permit system*: The pollution control authority determines a target level of environmental quality, translates this into the total amount of allowable emission that can be discharged (quantity control), and then allots discharge rights to firms in the form of permits. In setting up the trading rules the nature of the pollutant is important: for uniformly-mixed pollutants (eg. carbon dioxide) the marginal damage cost would be same across the sources, but for non-uniformly mixed pollutants (eg. sulphur dioxide) marginal damage costs across sources will be different and the trading prices need to reflect that. For the initial allocation of rights, the permits can be auctioned to the firms (to guarantee an efficient distribution of discharge rights) or "grandfathered" according to the base level of production (for political acceptability). Thus unlike pollution charges, the permit system ensures a given level of environmental quality, and allows for economic growth without further increase in pollution. However, for the efficiency of the system, the regulatory authority must be able to monitor the allocation of the rights and the environmental impact of permit trades. Under perfect information, the outcome of a marketable permit system can be replicated by an emission charge system, i.e. the systems are equivalent (in terms of price and quantity of pollution). However, with imperfect knowledge, the outcomes under the two systems can be different.

3) *Deposit refund system*: Consumers pay a fee when purchasing potentially polluting products. When the product is returned for recycling/ proper disposal, the deposit is refunded. The deposit-refund system can perform better than other economic instruments when "the act of environmental degradation is not directly observable or when the potential injurers are numerous and/or mobile"(Bohm and Russell 1985, p. 429). The system specifies the maximum economic loss to the consumer for non-compliance through the deposit, and this can be sensitised to the potential damages from non-compliance. The deposit-refund system for car hulks in the European Community has reduced the number of cars abandoned and promoted the re-use of car materials. An important advantage of the system is that most of the management remains with the private sector, and the incentive is built in for third party (eg. scavengers) when users do not participate.

2.3 *(B) Indirect market-based instruments*

These include instruments that are placed on goods which are indirectly linked to the emission of pollution. Thus the effectiveness of such taxes/charges crucially depends on the strength of the linkage between the transactions (to which the tax is applied) and the pollution that

the policy seeks to control. Five indirect MBIs are considered here:

4) *Product charges and differential tax rates:* Fees are added to the price of products or product inputs that cause pollution in either the manufacturing or consumption phase or, for which a special disposal system has been established (example, the product charge on lubricating oil in the EC, except Denmark, to recycle waste oil). Product taxes on goods which indirectly create pollution, are levied to alter the pattern of consumption towards cleaner goods. Differential taxation is used to promote consumption of products that are environmentally safe (example, tax differentiation between leaded and unleaded gasoline). Of course, the effectiveness of product charges critically depends on the availability of substitutes.

5) *User and administrative charges:* User charges are direct payments for the costs of collective/ public treatment of pollution (example, the collection and treatment of municipal solid waste). Administrative charges include fees paid to authorities for services such as chemical registration or the implementation and enforcement of environmental regulations. They are usually a component of direct regulation and primarily finance the licensing and control activities of pollution authorities (example, in Norway these charges finance the registration and control of fish farming and agricultural pollution, control of emissions from industrial sources, and the licensing of chemical products).

6) *Subsidies for substitute and abatement inputs:* Pollution subsidies include grants, low interest loans, and tax concessions to provide incentives to polluting agents and to encourage pollution abatement by helping firms to meet the compliance costs. A subsidy may also be provided for the production of a cleaner substitute (clean diesel vs. the standard type). Although a tax on pollution discharge is similar to a subsidy on pollution abatement in terms of the incentive effects in the short run, the long run implications under the two are different. While the tax typically reduces the firm's profitability, a subsidy can encourage entry into the industry resulting in greater number of firms and more pollution than socially desirable. An efficient alternative scheme, a la Mumy, is a combined charge-subsidy system where polluters pay for emissions above some mandatory baseline, but receive a subsidy for emission reductions below the baseline (Cropper and Oates 1992, p. 682). However, the Mumy scheme can be considered as an enforcement incentive mechanism encouraging compliance with the regulations.

7) *Enforcement incentives (non-compliance fees, performance bonds):* These are typically tied to direct regulation. Enforcement incentives include non-compliance fees or fines when the environmental standard is violated by the polluting firm. Performance bonds and liability assignment are also used, where firms post monetary bonds before operations begin. If the firms

pollute in excess of the acceptable levels, then they forfeit the bonds. Borrowing the expression of Bohm and Russell (1985, p. 432), this is a "producer-oriented deposit-fund". The bonds are primarily used in cases of clear environmental damage, such as surface mining (OECD 1992, p. 12).

8) *Suasive instruments*: Environmental education or information is used to alter the behavioural pattern of economic agents. It encourages the formation of voluntary agreements between firms and local authority/community, where the industry undertake large scale developments for standards more stringent than national standards. Also, public disclosure of information on polluting activities of industries promotes "environmental/ green labelling" of products, which creates a pressure in the marketplace to manufacture environmentally-friendly products. Improvement of public relations (with consumers) act as the incentive for the industry to opt for voluntary compliance.

3.1 Advantages of MBIs over command and control measures

Economic analyses and simulated empirical studies have shown that the use of market instruments in pollution control can be more than an order of magnitude less costly than regulatory strategies. The simulated studies on air and water pollution, mostly for the US, show that the cost to achieve an environmental quality target under a CAC measure can vary between 1.07 to 22 times the cost under an economic instrument like tradeable discharge permits (a survey of these empirical studies is given in Tietenberg 1991, p. 96). The *potential* cost savings from the use of market based instruments over command and control, in the simulated studies, arise from lower total abatement costs through a shift of the burden of abatement from high cost to low cost abaters. The market incentives push the polluters to opt for the best available technology, and by that achieve the socially optimal outcome (at minimum cost). In contrast, CAC measures apply uniformly to all polluters such that the same environmental quality has to be achieved by polluters irrespective of their abatement cost structures.

Besides the static cost-efficiency advantage of MBIs over the CAC measures, there is also a dynamic aspect. Since economic instruments use market incentives to reduce pollution, they offer the flexibility in the use of abatement technology to the polluting agents. In trying to achieve the cheapest means of pollution abatement, firms have an incentive to innovate and develop new control technology and expertise in the long run, thus R&D is encouraged for better abatement technology. On the other hand, under an emission or effluent standard there is no incentive to abate beyond the required level. Furthermore, mandatory environmental standards are generally based on the best available abatement technology in the economy at the time of legislation, and with the improvement in technological knowledge over time the norms are outdated.

In addition to cost-efficiency, economic tools have additional advantages over more conventional regulatory approach: When the technology required to meet the standards is not widely available outside the incumbent firms, CAC measures can act as a barrier to entry to new firms. Also, the use of market-based instruments, like pollution charges and user fees, provide revenue that be used in promoting environmental projects.

While the advantages of market-based instruments over command and control measures are well established[2], the choice within the set of MBIs is not as clear. A comparison of the various economic tools is discussed in section 3.2.

3.2 The choice between the different MBIs

Within the set of economic instruments, pollution charges and tradeable pollution permits have by far received the most attention in the literature. In the choice of an economic instrument for pollution abatement, the discussions (as also practice in the US) have favoured marketable pollution permits over pollution taxes/charges. One of the most important reasons is that, the tradeable permit system gives the control of the quantity of emissions (determined by the desirable environmental standard) to the regulatory authority, whereas under a tax system the pollution level would be determined by the polluters. Second, in a charge system, the authority needs to periodically adjust the fee (if set in nominal terms) to incorporate real changes due to inflation and growth. However, in the case of tradeable permit scheme, the permit market price automatically adjusts to such changes (with growth, demand for pollution permits would increase and so would the price, so long as new permits are not issued). In terms of the impact on environmental quality and cost of abatement, when there is no uncertainty about the abatement costs, the price-based instrument of pollution charge, and quantity-based instrument of tradeable permits have equivalent impact, but not in the presence of uncertainty.[3]

Also, when pollution permits are initially distributed free of cost to the polluters ("grandfathered") instead of an auction, the tradeable permit system would have an advantage in terms of political acceptability over a pollution fee (Baumol and Oates 1988, pp. 178-179). A pollution charge imposes a new tax bill on polluting firms, while a grandfathered system of permits favours incumbent firms. However, subsequent trades would be required to achieve a cost efficient outcome, since the initial free distribution (which does not reflect the marginal

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[2] However, Hahn and Stavins (1992, p. 465) point out that, given political and technological constraints, sometimes CAC measures may be better suited than MBIs for certain pollution problems. For example, when pollution is highly localized, with threshold (non linear) damage functions, source-specific standards may be appropriate. MBIs are particularly desirable when pollution is uniformly mixed over large geographical areas.

[3] In the presence of uncertainty of marginal abatement costs, the environmental quality (outcome) is not assured (since the pollution charge may not be at the appropriate level). Incidentally, for pollutants that pose serious health hazards, direct regulation is often used.

abatement costs of different polluters) will probably not be optimal. By providing valuable licenses to pollute free to existing firms, the regulator is discriminating against new firms. New sources would have a greater financial burden than otherwise identical existing sources. Tietenberg (1991, p. 98) notes that, "this new source bias could retard the introduction of new facilities and new technologies by reducing the cost advantage of building new facilities which embody the latest innovations".

The monitoring costs will be incurred in pollution tax, non-compliance fee, and tradeable permit systems. However, marketable permit schemes have the added cost of tracking the trades in the market (monitoring the allocation of pollution rights in the economy). Moreover, the advantages of the transferable permit system would not be realized if market imperfections prevent the market from functioning smoothly. For example, if information is imperfect in the market, then potential buyers and sellers of permits would not be able to engage in profitable trades. In the presence of distortions in the permit market (large search costs, strategic behaviour of the players), an emission tax system may be preferred since it would achieve a cost-effective pollution abatement. In the US, much of the trading involved large corporations: it is probably feasible for only large trades to absorb the high transaction costs without jeopardizing the gains from trade (Tietenberg 1991, p. 105). Thus, pollution charges may prove to be the more appropriate instrument over tradeable permits when sources are individually small, but numerous (ibid). With large transaction costs, the final equilibrium allocation of permits and hence the aggregate costs of control also become sensitive to the initial permit allocation (Hahn and Stavins 1992, p. 466). Thus grand fathering of tradeable permits in a situation with large transactions costs would not yield the cost-effective solution expected.

With regard to total abatement costs under alternative policies, a simulation study (Rahim 1994) of the palm oil industry in the Johor river basin, Malaysia, makes an important observation. The aggregate industry costs to achieve an environmental quality are compared under four systems: standards, effluent charges, standard-cum-charge, and tradeable effluent permits. For all the different environmental targets, a tradeable permit market prove to be the least cost option. However, the cost savings from such a market is more significant at the lower levels of abatement than at the higher levels of abatement. Moreover, the study notes that at the higher levels of abatement, the accompanying administrative and transactions cost could outweigh this relatively small edge in cost savings from pollution permits.

The choice of instruments is also influenced by the nature of pollutants involved, say when location of emission is an important factor. For non-uniformly mixed pollutants, where marginal damage costs differs according to distance from source, the optimal pollution charge rates would have to be different for different sources. While introduction of such a structure of tax rates on sources may be difficult, a tradeable permit market can have well-designed exchange rules to reflect this feature. However, the transactions system would be complicated. For uniformly

mixed pollutants, where the impact of pollution is uniform, emissions trading would work especially well.

Comparing a pollution charge with an abatement subsidy, it was noted earlier that, in the long run a subsidy can lead to a sub-optimal number of firms and quantity of pollution. On efficiency grounds, a pollution tax is preferable to a subsidy. With a subsidy, the polluter does not have the incentive to search for the cheapest pollution abatement technologies, and the subsidy may attract more firms into the industry (thus more pollution) than socially desirable.

In contrast to the price- and quantity-based MBIs, suasive instruments aim to change the behavioural structure in an economy, such that the environmental goals can be achieved voluntarily. Environmental education is aimed to alter the pattern of behaviour such that the system can operate without any governmental intervention: Green consumerism creates market pressure for environmentally friendly products, and the industry voluntarily undertakes pollution abatement projects in order to improve public relations. Such a policy also reduces administrative costs involved in the operation of other market-based instruments.

In this regard it must be noted that, indirect MBIs like product charges are effective in reducing consumption/ pollution when the price elasticities of demand of the goods are high, whereas the impact of suasive instruments is independent of the nature of demand. Since the suasive instruments aim to change the structure of demand towards environmentally-friendly products, the initial values of the price elasticities of demand are not as important. Finally, since the effectiveness of an indirect MBI (based on tax) depends on the strength of the linkage between the taxed product and the pollution targeted, when the linkage is imprecise, pollution reductions may not occur in the most efficient manner. However, with an information based instrument, pollution abatement would be achieved efficiently as the consumers and firms voluntarily change their behavioural pattern.

3.3 The revenue aspect

The use of pollution and administrative charges/fees, product taxes, and the auctioning of pollution permits can provide the government with a source of revenue, which may be earmarked for pollution control programmes. In Netherlands and Germany, the revenue from water effluent charges is used to finance projects in water quality management. Korea utilizes the air and water emission charge revenue to promote investment in pollution abatement technology and equipment through the Environmental Pollution Control Fund. In Poland too, the revenue from air emission charges is an important source of environmental project financing. In Britain, the water effluent charges (administered by National River Authority) are designed to cover the recurring costs of monitoring effluents and controlled waters. While Brazil uses the water pollution charges to cover the cost of public water treatment. In Japan, the revenue from emission charges is used to compensate for pollution related health damages. More interestingly, in Thailand, the surtax on

leaded gasoline finances the subsidy on unleaded.

User charges on water and sewage facilities in the state of New South Wales, Australia, were earmarked for a programme of environmental policy measures. In Bergen, Norway, the toll on motorists entering the city during 6am-10pm on weekdays, is used to finance the construction of by-passes through the surrounding mountains (once the by-passes are completed, the tolls will be removed). However, when pollution tax receipts are earmarked for particular programmes, it may create an incentive to set the tax rates according to the funding needs of the programme rather than at the optimal levels to correct for the negative externality (and reduce pollution to the desired amount). For instance, the road toll in Bergen is not sensitive to the time of day the motorist is using the road, although the marginal external cost a motorist imposes on the vehicular traffic and pollution may be different at different points of time.

Also, if some/ all of the pollution taxes are returned to firms as assistance for abating pollution, then the effectiveness of the tax (providing incentive to abate) would be reduced. For example, in France where emission charges are low and most of the revenue is returned to the polluters as a subsidy for installing abatement equipment, the charge system has not had much effect on the air quality (Tietenberg 1991, p. 91). In Sweden, however, the revenue from air pollution (NO_x) charges is rebated to the installation of emission measurement equipment by the firms, based on the firms' final energy production. The final revenue impact is zero, but there is a redistribution between high emitting- and low emitting plants.

3.4 The Equity Issue in Environmental Policy

While designing environmental policies, there is a concern for the accompanying equity effects on different income groups in the economy. The benefits and costs of environmental policies vary by income class and location. Most empirical studies on the distributional effects of pollution control costs cover regulatory (CAC) environmental programmes in the US during the 1970s-80s.[4] The studies show that the burden of the pollution control cost of the industry is shifted onto consumers through higher prices, and this has differential real income effects on different groups. Typically, the incidence of these cost was found to be regressive (the burden constituting a larger fraction of the income of the relatively poorer groups). It is likely that the distributional impacts of MBIs will be similar, since the same polluting industries would be the incur the abatement costs as under the CAC regime.

Such undesirable distributional effects of the costs of environmental policies, however, can be corrected through other accompanying measures. For example, pollution taxes may be applied together with cuts in other tax forms, so as to provide relief to the poorer section of the economy. If the increase in production costs of dirty industries leads to output and job losses,

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[4] See Cropper and Oates (1992, pp. 727-728) for highlights of some of these studies.

then assistance could be provided in the form of unemployment compensation, retraining programmes, or relocation. Indeed, such transitional reallocation problems are bound to arise when the economy is moving towards a more environmentally-friendly production- and consumption structure.

Since the main objective of environmental policy is the efficient reallocation of resources (correct the systematic distortion in the economy caused by the uncompensated negative externalities), they are not well-tuned to distribution objectives. To quote the observation made by one of the leading environmental economists: "It is important to remember that the basic objectives of taxes on pollution (or other environmental programs) are allocative in nature; their purpose is to achieve important targets for environmental quality. ... Where their adverse redistributional impact can be easily addressed, it is surely important to do so, but environmental measures should not, in general, be side-tracked on redistributional grounds." (Oates 1994, p. 129)

4.1 Application of MBIs in developed and developing countries

Each of the economic instruments discussed above have found application in both developed as well as developing countries. Of the direct instruments, pollution charges have been most common, and tradeable permits the least in all countries. On the other hand, among the indirect instruments, input-output taxes, differential tax rates, and user fees have found extensive application in the industrialized economies. By contrast, developing countries have made a relatively higher use of subsidies for substitute and abatement equipment, rather than input-output taxes, differential tax rates and user fees as have the developed countries.

Box 1 provides a comparative overview of the use of MBIs across the developed and developing world, and highlights some of the notable experiences with these instruments. For a detailed country application, refer to the tables provided at the end of the paper.

Box 1. Number of countries using MBIs for pollution control

Economic instrument	Number of countries		Remarks
	Developed	Developing	
A. Direct MBI:			
1. Pollution charge	19	9	Germany & Netherlands introduced water effluent charges early with considerable success. Emission (NOx) charge in Sweden, and BOD load charge in Malaysia have also been successful. System was ineffective where charge was lower than the marginal abatement cost, as in Lithuania, Poland and Yugoslavia.
2. Marketable emission permit	5	1	US has made the most extensive use, with success in air pollution permits.
3. Deposit refund	18	4	Finland, Japan, Norway, Sweden, Taiwan, & the US have achieved return rates of 80-100% on some of the recyclable products. A low deposit resulted in a low return rate, as in Korea.
B. Indirect MBI:			
4. Input-output tax, differential taxes	23	5	Britain, Denmark, Germany, Netherlands, Sweden, Taiwan, Thailand, and the US have been successful in promoting unleaded petrol by making it cheaper than the leaded. Low product charge on lubricants in France failed to reduce used oil pollution.
5. User/ administrative charge	22	3	Singapore succeeded in reducing traffic congestion with well-designed road user fees, complemented with a strict non-compliance fine system.
6. Subsidy for substitute & abatement inputs	13	11	In Netherlands subsidies helped reduce water pollution and increase compliance. Sweden subsidized production of clean diesel with remarkable success.
7. Non-compliance fee	8	8	Successful in reducing COD pollution in some provinces of China. In Mexico, fines (combined with threat of closure) was effective. In Brazil and Korea the fines were too low to be effective.
8. Suasive instrument	5	3	Industries in Netherlands and Japan voluntarily reduced pollution considerably. Indonesia too has scope for such a success.

4.2 Performance of each of the instruments:

Environmental pollution control in the Western Europe and the United States had begun with command and control strategy, and over time was supplemented with economic instruments. In most European countries the taxes and charges (greater role of the state) have been extensively used rather than tradeable permits, as compared to the United States. The taxes in some European nations, however, have not been set at rates sufficient to create much of an incentive to reduce pollution. So far, the US has made the most extensive use of tradeable pollution permits. Although, substantial savings in abatement costs have been estimated (Hahn 1989) trading has been less vigorous than anticipated. For example, the trade in SO_2 permits of electric utilities under Title IV of the 1990 Clean Air Act Amendments is believed to be low due to the design of the markets and regulation of the power industry's profits. Consequently, multiple prices have emerged in the permit auctions, and prices have been lower than expected, making potential sellers reluctant to trade permits at the low prices (US GAO Report 1994, p. 3).

In contrast to the developed countries, fewer developing economies have implemented economic instruments for the control of industrial pollution. The early application of MBIs in industrial pollution abatement in Malaysia took the form of effluent-licence fees on palm mills in 1978, and in China as non-compliance fees on atmospheric emissions in 1979. There has been some use of air pollution charges/taxes in Korea, Poland, and Russia in recent years, but it is not known how well the system has performed. Chile is the only developing country which has implemented a tradeable pollution permit scheme to reduce air pollution in Santiago from stationary sources and buses (Margulis 1994, p. 116). Since the system lacks a clear definition of the property rights, and rules of the game, the permit market has not been effectively set up.

To examine the effectiveness of each of the eight MBIs, the performance of each instrument in terms of success and failure in some of the countries is discussed below.

1) Pollution charges:

Developed countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Portugal, Spain, Sweden, Switzerland, Turkey, the UK, and the US.

Developing countries: Brazil, China, Estonia, Korea, Lithuania, Malaysia, Poland, Russia, and Yugoslavia.

Water charges in Netherlands, Germany and Malaysia have been successful in improving the quality of water. Air pollution charges in Sweden achieved an emission reduction greater than the target. However, emission charges in China, Estonia, Lithuania, Poland and Yugoslavia have not been as effective in abating pollution.

In Netherlands water effluent charges were implemented in 1969. The charges, based on

amount of the pollutant, were used in the construction and operation of sewage treatment plants. Statistically, in 1975-80 an increase in the charge rates played the most important role in reducing heavy metal pollution, and to a lesser extent in oxygen-consuming pollution. The water authorities played a catalytic role: A water board official is quoted to have said that "When I'm going to have a talk with a company about abatement of their discharges, I always take my pocket calculator along. I calculate their potential savings on charges and invariably get an interesting conversation started" (Bressers 1994, p. 167).

In Malaysia, a system of effluent-related licence fees on the BOD load discharged by palm oil mills was introduced in 1978. The license mimicked a 2-part tariff, with a variable effluent-related fee and a flat administrative fee: RM 100/tonne for BOD loads exceeding the legal standard and RM 10/tonne for BOD loads equal or less than the standard; plus a non-refundable RM 100 as annual licence-processing fee. Discharge onto land, instead of a watercourse was RM 50/1,000 tonnes regardless of the concentration. Between 1978-81, the total BOD load discharged reduced by 94.2%, despite the rise in the number of mills. However, the risk of shutting down rather than the effluent fee seem to explain the result, since the regulations became mandatory during 1979-81 (Rahim 1994, p. 69).

In Germany, the system of wastewater charges was introduced nation-wide in 1983 (although charges were administered by water management cooperatives, or Genossenschaften, since the beginning of the century). Charges apply on discharges into rivers, lakes, sea and the groundwater by both industrial and municipal sources. The charges are normally based on expected volume and concentration for the year ahead, and the compliance is largely self-monitored (subject to random spot checks). The system was accompanied by mandated norms, and the revenue was used to cover expenses of projects in water quality management. In general, the system is perceived to have improved water quality, although there is scope of increasing efficiency (Bohm and Russell 1985, p. 403-404; Smith 1995, pp. 25-31).

In Sweden, air pollution charges on emissions of nitrogen oxides were imposed on the heat and power producers (capacity exceeding 10MW and producing over 50 GwH) in January 1992. Where emissions could not be measured, standard emission rates were used. These rates were greater than the average actual emissions, and consequently encouraged the installation of measurement equipment by the firms. All revenue was rebated to the firms, based on their final energy production, to speed up the process of compliance with emission target. The final revenue impact was zero, but there was redistribution between high emitting and low emitting plants. The emission reduction achieved in 1992 was 30-40%, while the target had been only 20-25% (OECD 1994, p. 59).

However, in China, Estonia, Lithuania, Poland and Yugoslavia the charge rates have been too low (less than the marginal abatement cost) to provide adequate incentive to the firms for pollution abatement.

2) Tradeable permits:

Developed countries: Australia, Canada, Germany, Singapore, and the US.

Developing country: Chile.

So far, the United States has made the most extensive use of tradeable pollution permits with reasonable success. Singapore and Chile have also introduced the system in the transport sector recently.

In the US, emissions trading was introduced in 1974 (netting), and enhanced over the years to include more types of transactions (bubbles, banking, offsets). Pollutants covered include VOC, CO, SO_2, NO_x, and particulates. By 1986, 7,000-14,000 internal trades, and some 200 inter-firm trades had taken place: the abatement cost savings, $935-$12,435 millions, though substantial, was less than expected. Trade in lead credits, to phase out lead in gasoline in 1982-87, has had the best performance. The trading of lead credits gave gasoline refiners flexibility in significantly reducing lead in the fuel during the period. Limited banking of the permits were allowed three years after the programme was introduced, and this allowed firms to carry over the rights forward. Interrefinery trading did not discriminate between old/new sources, nor between large/small sources. The level of trading in the lead credits market surpassed those observed in other environmental markets. In 1985, more than half the refiners participated in credit trading, and about 15% of the total lead credits in use were traded. In terms of "creating a workable regulatory mechanism that induces cost savings" the lead credits programme is considered to be a success (Hahn 1989, p. 101-102).

Singapore introduced a marketable permits system for rights to import ozone-depleting substances (CFCs under the Montreal Protocol) and to own motor vehicles ("certificates of entitlement") in 1990. For CFCs, half the quotas are grandfathered and half are allocated through sealed bid tenders. The auction allows the government to capture a substantial portion of the quota rents, which have been used to subsidize recycling services and diffusion of alternative technology. By mid-1992, the vehicle quota premium for standard cars rose to US$ 12,000. This and complementary policies (eg. ALS) restricted the growth in car ownership and traffic (O'Connor 1995, p. 16-17).

The performance in Chile, the only developing country with a tradeable permit since 1990, has not been evaluated so far. The city of Santiago, Chile, allocated bus transit rights and auctioned routes based on fares and types of buses in 1990 to reduce air pollution. Since, after deregulation of the public sector bus monopoly in the 1970s, cheaper and more polluting buses began operating in the city. A tradeable permit system for industry was also introduced on fixed sources, with emissions exceeding 1,000 m^3/hr. The system allocates the maximum level of daily emissions of existing sources, and any emission above this limit must be compensated by a reduction of emission from some other source (offset mechanism). Emission tradeoff, however,

is not allowed beyond a day, nor across seasons, and the property rights are not well defined (Margulis 1994, p. 116).

Even when the necessary institutional structure is present, the presence of regulatory restrictions and uncertainty can impede the efficient performance of the pollution permit market, as witnessed in the US. In the US, tradeable permits market have performed well where the rules of the game were clear and there was no discrimination among the various pollution sources, as in the case of gasoline lead credits in 1982-87. However, in an environment of regulatory uncertainty regarding future rules and of capital cost recovery amongst the polluters, a thin permit market emerged in the sulphur dioxide permits of the electric utilities during 1991-92. Because, if firms cannot retain some fraction of the benefits from trading they would have little or no incentive to engage in trades (Hahn and Stavins 1992, p. 465).

The performance of water effluent permits in the state of Wisconsin, US, was also disappointing. In 1981, the state implemented marketable discharge permit programme to control BOD on a part of the Fox River. Each permit defined wasteload over 5 years, for 10 pulp and paper firms, and 4 municipal waste treatment plants. Till date however there has been only one trade. This could be a reflection of the fact that the firms involved had similar levels of marginal costs of abatement. In Colorado state, tradeable rights to discharge phosphorous into the Dillon Reservoir was introduced by the local government, but by 1992, no trade had been approved (Hahn 1989, p. 97; Cropper & Oates 1992, p. 691).

3) Deposit-refund:

Developed countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Japan, Netherlands, Norway, Portugal, Sweden, Switzerland, Turkey, the US.
Developing countries: Estonia, Hungary, Korea, and Taiwan.

The deposit-refund schemes in Finland, Japan, Norway, Sweden, Taiwan, and the US for certain recyclable products has achieved high rates of return. In Finland, beverage bottles have a return rate of 90%, and in the US (10 states) a refund of 5-10 cents has achieved a return rate of 80-95%. In Taiwan, for PET bottles, the refund rate increased from 36% in 1989 to 80% by 1992 with a deposit rate of NT$ 1/bottle (Pan 1994, p. 90). Under a voluntary deposit refund system, Japan achieved a collection rate of 92% in 1989 for beer bottles.

Return of car hulks are typically mandatory in Europe, and Norway has a return rate of 90-99%. In Rhode Island, US, automobile batteries have a mandatory deposit of $5, paid at the time of sale. The dealers hold the deposit (returned if a used battery is returned within seven days of purchase), and are required to return 80% of the deposit funds they hold to the state. This system is also considered to be a success (Bernstein 1993, p. 56).

In South Korea, however, the return rate of the recyclable products (and those creating

voluminous or toxic waste) was only 8% by 1992. The disappointing result is probably explained by the low deposit mandated (Rhee 1994, p. 99). In Estonia, the deposit-refund system for glass bottles is poor, and the lack of sufficient return outlets is a major cause (OECD 1994, p. 136).

4) Differential taxation:

Developed countries: Australia, Austria, Belgium, Britain, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Sweden, Switzerland, and the US.

Developing countries: Hungary, Korea, Mexico, Taiwan, and Thailand.

In differential product taxes, countries have favourably treated unleaded gasoline over leaded gasoline, and diesel fuel (diesel engines emit more smoke, toxic particulates, and polyaromatic hydrocarbons, which is toxic and possibly carcinogenic) over gasoline. Unleaded gasoline is cheaper than leaded in a large number of countries including Australia, Britain, Denmark, Finland, Germany, Netherlands, Norway, Sweden, Taiwan, Thailand, and the United States among others. In Denmark, the market share of unleaded petrol is nearly 100%. Fertilizers are also subject to a charge (Austria, Finland, Norway, Sweden and the US), based on the nitrogen/ phosphorus/ potassium content in some cases. Norway and Sweden also have taxes on pesticides. Italy had introduced an incentive charge on plastic shopping bags in 1988, which succeeded in reducing its consumption by 20-30% immediately (OECD 1994, p. 82). The Italian plastic tax was replaced in 1994 with a recycling contribution on virgin polyethylene.

In Britain the proportion of unleaded petrol in total petrol sales increased to 50% in 1993 compared to a negligible share in 1986. The tax differential between leaded and unleaded was initially 0.96 pence per litre, and increased over time to 4.8 pence per litre by 1995. In Germany, the duty differential is DM 0.1 per litre and the market share of unleaded petrol in total petrol sales rose from 11% in 1989 to 80% by 1993. As in most European countries, the tax differentials ensured that the marginal saving in buying unleaded petrol vs leaded outweighed the fixed costs of converting cars to run on unleaded petrol for all except those doing a few miles per year (Smith 1995, pp. 109-110)[5].

In Taiwan, a price differential of NT$ 1/litre between unleaded and leaded gasoline was introduced in 1989. Complemented with other regulations on new cars and emissions, the market share of unleaded petrol increased from 18.7% in 1990 to 51.84% in 1993 (Pan 1994, p. 91).

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[5] It is unlikely that a further increase in the leaded-unleaded differential will increase the adoption of unleaded petrol in Europe, since the existing differential has achieved most: Smith argues that, the remaining users of leaded fuel contain a disproportionate number of owners of older cars, used for relatively low mileage; others may simply be poorly informed and unlikely to be responsive to marginal adjustments to the fiscal differential (Smith 1995, pp. 110-111).

The average lead content in ambient air in Taipei decreased by 50% between 1989 and 1992. Thailand began promoting unleaded gasoline in 1991, following the 1990 USAID study (which estimated a loss of upto 700,000 IQ points collectively of Bangkok children by age 7 due to elevated blood lead levels). The surtax on leaded gasoline is used to subsidize the unleaded variety. In Bangkok, unleaded petrol accounts for 40-50% of the gasoline market (O'Connor 1994, p. 46).

Unfortunately, along with the leaded-unleaded gasoline price differential, almost all countries have maintained the price of diesel fuel lower than gasoline. Cheap diesel helps to lower the cost of freight transport and public transport. For example, in Japan, in 1991, gasoline prices were two-thirds higher than automotive diesel fuel prices, in part because the tax rate on the former was 10% points higher than the latter (O'Connor 1994, p. 47).

The exception to the policy of uniform diesel tax rebate can be found in Sweden, where use of clean diesel fuel is encouraged. In 1991, Sweden classified diesel fuel into three types, based on environmental characteristics (sulphur content). Simultaneously, differential tax rebate to diesel producers was introduced: highest rebate offered for the cleanest (class I) and the lowest for the standard diesel (class III). After the revision of these rates in 1992, the share of cleaner diesel fuel increased to almost 75% of the total diesel sales by the end of the year. Tax differentiation also stimulated R&D in the field, and Sweden now sells environmentally improved diesel as well as technology in the international market (Bergman 1994, p. 254).

Netherlands reduced the sales tax on cars which complied with future European standards and raised it for dirtier models. Consequently, in the 1980s, the share of future European standard cars rose from 37% to 70% in the small car market (which constitutes 2/3 of the car market) at a rate faster than expected by the Dutch Ministry of the Environment (Bressers and Schuddeboom 1994, p. 156). The Swedish tax on polluting vehicles and subsidy for new low-polluting vehicles was successful in introducing low-polluting vehicles at a much faster pace than otherwise. However, the programme proved to be costly, since the subsidy payments exceeded the tax revenue (Tietenberg 1991, p. 91).

In France, however, the product charge on lubricants was not as successful. The tax was imposed on the manufacturers and importers of lubricants, and complemented with regulations on collection, storage and disposal of used oil. Since the charges were low, the incentive impacts have been insignificant (Bernstein 1993, p. 59).

5) User fees:

Developed countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, Turkey, UK, and the US.

Developing countries: Chile, Colombia, and Russia.

A large number of developed countries have user fees for water treatment plants and sewage services, or for waste disposal. Norway and Singapore have applied user fees on roads to address the problem of traffic congestion and air pollution. Among all the countries, Singapore has perhaps made the most remarkable use of this policy.

To reduce traffic congestion in the city, Singapore implemented the Area Licensing Scheme (ALS) in 1975. A vehicle entering the restricted zone (encompassing 620 hectares) required a licence ticket on a daily/monthly basis for the peak hours (7:30 am 10:15 am on Monday through Saturday, and extended to include 4:30 pm to 6:30 pm in 1989-90 on weekdays). By 1989, the fee was highest for company cars, less for private cars/taxis, and least for motorcycles. The fine for non-compliance was about ten times the daily licence price. In 1988, the average violations/day was 100, while the number of licences/day issued was 12,000. The restricted zone also has higher parking fees, and strict enforcement at 28 points of entry to the zone. Although car traffic rose after 1977, private car traffic was 64% below the pre-ALS flows by 1982 in the peak hours, despite the growth in income and employment. Complemented with other policies, ALS helped reduce the smoke and acidity in the city air. (Buchan 1994, p. 220, World Bank 1995, p. 69; Bernstein 1993, p. 48).

The city of Bergen, Norway, also has a road toll for motorists entering the city between 6am and 10pm on weekdays, differentiated according to the loading capacity of vehicles[6]. Although the system does have an effect on reducing congestion and pollution, the system can be improved by designing higher tolls for the peak hours only. The system is primarily used to finance the construction of by-passes through the surrounding mountains in order to keep the long-distance traffic away from the city centre (toll revenue was 56 million Nkr in 1986, 59 million Nkr in 1988) . After the by-passes are completed, the tolls will be removed (Henry 1990, p. 261)

6) Subsidies for substitute and abatement inputs:

Developed countries: Australia, Austria, Canada, Germany, Finland, France, Ireland, Japan, Netherlands, Norway, Portugal, Sweden, and the US.

Developing countries: China, Estonia, Hungary, India, Indonesia, Korea, Lithuania, Mexico, Taiwan, Thailand, and Yugoslavia.

Tax incentives for investment on abatement technology/ equipment has been the most common form of subsidy in the industrialized countries. In the developing countries similar fiscal incentives have been offered, but also include rebates in import duties. In Sweden a subsidy was offered for the production of cleaner diesel (substitute), and proved to be quite successful. The policy of subsidy in environmental investment has been effective in Netherlands too. In the other

[6] I am grateful to Professor Agnar Sandmo for bringing this to my attention.

countries there is no evidence to suggest whether subsidies have encouraged pollution abatement.

In Netherlands, subsidies offered for the removal of heavy metals in industrial effluents, and for replacement of PCBs in certain products (coolants, transformers, condensers) were successful in reducing pollution. The subsidy on water effluent treatment is believed to have improved the relations between water management and the industry, and also enhanced the effectiveness of other policy instruments like charges (Bressers and Schuddeboom 1994, p. 154). On the other hand, 72% of all PCBs were replaced during 1984-89. But the subsidy scheme may account for only 32% of this reduction while the rest is attributable to other variables (ibid).

7) Enforcement incentives:

Developed countries: Australia, Canada, Germany, Italy, Japan, Sweden, Turkey, and the US.
Developing countries: Brazil, China, Estonia, Hungary, Korea, Lithuania, Mexico, and Russia.

Environmental regulation is usually accompanied by non-compliance charges, and are common both in the developed and developing countries. The effectiveness of the charges is determined by, both the level at which the fee has been set (greater than marginal cost of abatement to encourage compliance) and how strictly the measure is implemented.

Among the developing countries, the policy is seen to have been partly effective in China. China introduced a legal charge on industrial emissions exceeding the norms, based on amount and concentration in 1979. In 1981 the system was extended nationwide, although factories in different regions face different penalties for polluting. In 1982-86, the compliance rate of steel industry with discharge standards increased from 33.5% to 60.4% (Potier 1995). Charges, however, are relatively light, and the firms are penalized only for the worst offending pollutant. The penalty fee is based on the percentage deviation of the pollutant discharge from the norm. A recent study (Wang and Wheeler, 1996) using panel data from 29 provinces for 1987-93 to examine the charge system in China, concludes that contrary to the conventional critique, the water pollution levy scheme was effective in reducing the COD pollution in the provinces. The authors observe that community enforcement of effluent standards determined the "effective price of pollution" in each area, and the local assessment of damage in the provinces played an important role in reducing pollution. During 1987-93, with rapid industrial growth, there was a sharp rise of the effective effluent charge rate in the Chinese provinces, and industrial emissions reduced significantly. The COD intensities in the various provinces declined at a median rate of 50%, and the total COD discharges reduced at a median rate of 22%.

In South Korea the fines for the violation of the mandatory norms, on air and water emissions, have not been high enough to encourage compliance. In Brazil, the penalty system has operated in an arbitrary manner since its introduction in 1981. For example, fines on atmospheric emissions are often visually assessed as a lot/ some/ little smoke in some of the major cities like

Rio de Janeiro etc. .Furthermore, Brazilian state-owned firms are exempt from fines for violations of water standards (Margulis 1994, p. 110). In Turkey, in the cities of Izmir and Istanbul, fines for non-compliance with water effluent standards have not provided adequate incentive effects, since companies often litigate to delay or avoid payment!

8) Suasive instruments:

Developed countries: Denmark, Germany, Japan, Netherlands, and the US.

Developing countries: Bangladesh, China, and Indonesia.

Suasive instruments have been successfully used in Japan and a few European countries. Japan has used voluntary pollution control agreements as local environmental policy measure since the 1950s. The Japanese government reduced its involvement in industries at a quick pace and the success followed from this decrease in government intervention (Murty 1996c, p. 35, quoting Odagiri 1994). By 1991 about 37,000 agreements were in force, of which 259 had been reached without local government involvement (James 1996, p. 69). Several of these agreements involved local citizen participation in the form of independent contracts between citizens and industry.

In 1989, Indonesia introduced a clean river programme, PROKASIH, between provincial governors and company directors; and targeted the 20 dirtiest rivers. More than 1,000 industrial operations entered into agreement and the majority undertook measures to reduce pollution loadings. Firms with the heaviest pollution loads were asked to draw up pollution abatement plans. In 1990-94 there had been a drop in BOD levels in the rivers, but the levels have increased since (O'Connor 1995, p. 17). Another programme, PROPER, encourages industry to meet industrial standards on effluent discharge: government publishes environmental ratings of firms based on pollution performance, to generate positive publicity. The industries are labelled as: "gold" if they meet the international standards of effluent discharge, "green" if they meet the national standards, and "blue", "red" or "black" according to worsening levels of performance on pollution control below the national standards. During June-December 1995, there was a distinct move of "black"/"red" rated firms towards the "blue" group (James 1996, p. 73). Thus, the positive publicity element in the PROPER programme seems to have worked well.

5 Policy Lessons for India

The widespread use of MBIs in the economies across the globe provides critical lessons in emulating similar policies in India. The experience especially of developing nations like China, Indonesia, Malaysia and Thailand besides other countries in eastern Europe, is useful, since India can identify with similar institutional and structural problems. Both the successes and failures offer lessons to make environmental policies more effective in India.

India has witnessed a phenomenal growth in polluting industries like chemicals, fertilizers,

paper and pulp, and distilleries among others, in the last four decades. Moreover, the government's aid to small scale industries (and agriculture) through subsidised electricity and water (and fertilizer/ pesticide), has helped in the suboptimal use of energy/ water/ chemicals which in turn has added to certain pollution problems like ground water contamination through chemical leaching. The only green economic instrument that has been in use in India is the water cess[7]. The water cess, however, is primarily aimed at raising revenue for the state pollution control boards, and the rate of the cess is too low to stimulate water conservation measures. There are also tax rebates offered for investment in pollution control equipment[8], and a scheme of prison penalty (with fine) for non-compliance with environmental norms. As to how effective the latter measures have been in providing the industry incentive to invest in pollution control equipment, there is no evidence. Meanwhile, the air pollution from the industry and vehicles have reached appalling levels, and industrial effluents continue to contaminate surface and groundwater.[9]

While considering the appropriate choice of economic instruments for pollution control in India, it should be noted that adoption of these tools does not mean that the entire institutional framework of a regulatory regime will become redundant. While MBIs can potentially achieve more cost-efficient solutions than CAC instruments, some of the underlying requirements for effective functioning of the two sets of instruments are the same.

The implementation of market based instruments has certain institutional prerequisites, like well-functioning markets, information on the types of abatement technology available and its cost (O'Connor 1995, p. 23-24). For example, the collection of an emissions charge depends on a reasonably effective tax administration, and monitoring of the actual emissions; and tradeable permit schemes require an institutional machinery for issuing permits, tracking trades and monitoring the actual emissions. Since the development of these structural capabilities are crucial

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[7] Although India has well-developed regulatory measures for environmental protection with legislations: Motor Vehicles Act 1938 (amended 1988), Wildlife Protection Act 1972, Water (Prevention and Control of Pollution) Act 1974 (amended 1986), Water (Prevention and Control of Pollution) Cess Act 1977 (amended 1988), Forest Conservation Act 1980, Air (Prevention and Control of Pollution) Act 1981, Environment Protection Act 1986, and Public Liability Insurance Act 1991.

[8] The import duty concessions on abatement equipment were removed in July 1996. There are penalty schemes for default of standards set by the environmental acts (e.g. 1974 Water Act, 1977 Water Cess Act, 1981 Air Act, Environment Protection Act, and 1991 Public Liability Act). The cost of non-compliance ranges from 3 month imprisonment with Rs 10,000 fine, to six years imprisonment with a fine of Rs 1 lakh. The non-compliance penalties, however, are not sensitive to the degree of violation. (CII 1995, p. 54-59)

[9] There have been several news reports from across the country indicating this trend. For example, the complete poisoning of the aquifer by chemical factories in Bichhri, Rajasthan; toxic waste contamination from drug factories in Bidar, Karnataka (*Down to Earth*, April 30, 1996, pp. 27, 38). Levels of suspended particulates in the air in cities like Delhi and Calcutta measure 460 mg/m^3 while the maximum permissible limit fixed by the WHO is 200 micro grams/m^3 (*India Today*, December 15, 1996, p. 47)

for the effectiveness of the instruments, MBIs cannot be considered as a short cut to pollution control. In other words, MBIs have institutional requirements just as regulatory measures do.

Interestingly enough India is comparable to a country like Japan in terms of the share of government revenue and expenditure in GDP at 24% and 36% respectively in 1992-3 (Murty 1996c, p. 40). However, India differs significantly in terms of the expenditure allocations: Higher proportions of public expenditure is market distortionary (outlays on the supply of private goods, non-marketable and public goods), while a small proportion of it is market-correcting (outlays on health, environmental protection etc), which is typical of a developing country (ibid). It is thus necessary to remove the distortionary measures before correcting for any environmental externalities. For example, any measure to reduce pollution from the use of chemical pesticides and fertilizers would be less effective, or ineffective, while a subsidy for these farm inputs to help agriculture is maintained.[10]

The policy lessons in pollution control for India from the rest of the world can be itemized as follows:

1. *Removal of distortionary subsidies* that lead to overuse of certain products and consequently more pollution (eg. the use of chemical fertilizers and pesticides leading to chemical runoff into surface and ground water). Otherwise, the effectiveness of any economic instrument to correct for the pollution problem would be hampered. Some countries like Austria, Finland, Norway and Sweden have already implemented fertilizer taxes based on the nitrogen and phosphorus content.

2. *Use of pollution charges for air and water effluents from industries* with a large number of small firms. Since scale economies in pollution abatement equipment may prevent small firms from taking such investment. Although, in the long run, it could encourage the firms to adopt more environmentally-friendly technology of production (versus the end of pipe pollution treatment) to avoid the pollution fees. The pollution charge has to be set so as to offer the incentive to abate pollution (charges set at lower rates than marginal abatement costs have failed to reduce pollution in Poland, and Yugoslavia).

3. *Introduce pollution permits for uniformly mixed pollutants from industries with large firms*, which would be better able to absorb the transactions costs in the exchange of permits. This is the lesson from the success of lead credit trading among refineries in the US.

4. *Develop a good monitoring mechanism of discharges from the sources* to ensure the

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[10] A study by the Geological Survey of India, on arsenic poisoning of groundwater in West Bengal, suggests that the heavy use of phosphatic fertilisers may have caused local leaching of arsenate compounds from the soil and aquifers into the groundwater (*Down to Earth*, October 15, 1996, p. 14).

effectiveness of any MBI that is adopted (even to ensure compliance with existing regulations). Where it is difficult to measure emissions directly, a standard rule that encourages the true reporting of emissions from the sources (Sweden succeeded in promoting a system of self-monitoring among large firms[11]). The same practise offers a feasible monitoring mechanism for large industrial houses in India, since monitoring can be rather costly for the government.

5. *Apply user fees to cover costs of common effluent treatment plants and to reduce vehicular congestion/ pollution.* Scale economies in pollution abatement typically make it infeasible for small firms to install individual treatment of waste discharge, hence common treatment plants with user fees would be an effective and efficient means of reducing industrial discharges. Besides this, to reduce vehicular traffic and air pollution in peak hours in the cities, user fees should be introduced (as the road fees in Singapore) differentiated according to the damage cost imposed by type of vehicle .

6. *Introduce enforcement incentives likes fines for violating standards* to encourage abatement and compliance. The charges should be sensitised to the amount of pollution above the limit (pollution load, rather than just concentration) as in China, reflecting the extent of violation. The current set of punitive prison threats in India does not incorporate this feature.

7. *Introduce deposit refund schemes for polluting products* like batteries, refrigerators, tires, etc. The deposit rate should be set at a level high enough to encourage return of the targeted products (so as not to repeat the mistake in Korea). Return rates as high as 95-100% are achievable (as in Europe, and the US), and in India there already exists a recycling market for glass, paper, and certain metals and plastics in the informal sector. Thus the concept of deposit-refund can be readily extended and accepted.

8. *Introduce differential taxation to favour the use of cleaner substitute products* (like unleaded vs leaded petrol). Small price differentials can sometimes achieve the eco-friendly consumption patterns (as in Europe, and Taiwan).

9. *Increase environmental consciousness* by providing information on polluting activities and environmental quality at the local level. This will encourage compliance with existing measures and also prompt industry to adopt voluntary projects for pollution abatement, as experienced in the east Asian countries of Japan and Indonesia.

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[11] In determining the NOx charges of firms, standard emission rates were used wherever emissions were not measurable. These rates were greater than the average actual emissions, and consequently encouraged the installation of measurement equipment by the firms.

The actual enforcement of an instrument determines the effective price of pollution. There is an important empirical lesson for a developing economy from the Chinese experience with a system of water effluent penalty charge, where evaluation of damages from pollution and enforcement of regulation at the provincial level played a significant role (Wang and Wheeler 1996). Moreover, the study points out that early in the regulatory process, when abatement is in a low-medium range, industrial emissions is highly responsive to the price of pollution (ibid). *In India, where the level of pollution abatement is rather low, this is a clear indication of how important it is to improve enforcement capacities and to adopt economic instruments in pollution control.*

The effectiveness of MBIs like pollution charges and permits depends crucially on the ability to successfully monitor emissions of the polluters (also required to enforce a CAC measure like ambient standard). Regarding the technical ability to monitor emissions, Tietenberg (1980, p. 255, quoting Anderson, et al. 1977) notes that, it may be feasible for larger firms where suitable measurement instruments are available and the cost is small relative to the overall operation of the plant. However, when direct continuous monitoring of emissions is not available to the regulator, other techniques may be used as substitute measures. For example, the data on input and output can be used to estimate the actual emissions as long as the production function relationship between these variables are known (ibid).

Even with the establishment of effective monitoring and enforcement capabilities, economic instruments are unlikely to replace the traditional regulatory instruments in developing countries like India. In fact, the industrialized countries too have implemented the MBIs for pollution control in a regime with CAC measures. However, if regulatory measures impede the functioning of MBIs (as in the case of SO_2 permit market of electric utilities in the US), then it is may be judicious to remove/ replace some of the existing laws.

Lastly, India has been using a top-down approach in environmental policy, while there exists the scope gains from the involvement of local community in this respect. The success of Japan (and Indonesia to some extent) with suasive instruments highlights the potential of a bottom-up approach for us. As noted earlier, environmental information and education offers a sustainable mechanism for controlling pollution, since an educated community exerts pressure on industry to adopt environmentally-friendly behaviour through green consumerism. Polluting firms then have an incentive to comply with regulatory standards, and sometimes even take voluntary measures to abate pollution further. The role of the government can reduce to being a catalyst in encouraging local initiatives. This would decrease administrative cost burden of the central government. Environmental education would also encourage households to be less wasteful and increase recycling. For a large and diverse country like India, such an approach seems both viable and attractive.

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ANNEX

TABLE 1A: DIRECT INSTRUMENTS (Developed Countries)

1. Pollution charges

Country	*Medium*	*Description*
Australia (province)	Water	Firms in the province of South Australia pay waste water effluent charges based on pollution load. The charge is imposed on actual measured effluents and levied through discharge licenses. (OECD 1994, p. 68)
Austria	Land	In 1989, introduced tax on solid waste disposal (supplied to processors such as landfills and incinerators) and the revenue is used for treatment and recycling. The charge rate was ECU 2.4/ton by 1994. Hazardous wastes face a charge of ECU 12/ton, and the revenue is used to clean up contaminated sites. (EPA 1992, p. 9-1; OECD 1994, p. 63-65)
Belgium (regions)	Water, land	In 1990 the Flemish and Wallone regions introduced an effluent charge on firms, based on the pollution load covering BOD, COD, suspended materials, nutrient load, and heavy metals. (OECD 1994, p. 68-69; OECD 1995, p. 41) There are also hazardous waste charges in the range of ECU 8-63/ton, and the revenue is used for environmental expenditure. (OECD 1994, p. 65)
Canada (provinces)	Air, water	British Columbia introduced permit fees on pollutant emissions in 1992. The fees are reduced if the actual emissions are less than the permitted emissions. (OECD 1994, p. 57) Alberta and British Columbia levy water effluent charges based on actual pollution load. The rates are differentiated according to the degree of toxicity of pollutants. Alberta has reported positive incentive effects. (OECD 1994, p. 68-69)
Denmark	Water, land	City of Copenhagen introduced water effluent charges in 1979. To cover the cost of effluent treatment, a surcharge was placed on firms with discharge worse than the average quality of sewage. Except for Copenhagen, Danish waste water treatment plants are not self-financing. (James 1996, p. 66) Solid waste tax introduced in 1987, based on the weight supplied to landfills and waste incinerators. Waste removed from landfills and incinerators is subtracted from the charge base. In 1987-89 the total registered waste supply decreased by 12% and waste removed rose by 7%. However this has led to excessive use of building waste as filling material for road making. (OECD 1994, p. 64)

Finland	Land	There is a tax on hazardous waste at the rate of ECU 270/ton on average, and the revenue is used in waste processing. (OECD 1994, p. 65)
France	Air, water, land	In 1985, atmospheric emission tax was introduced (extended in 1990) on operators of fuel installations (capacity > 20 thermal MW), waste incinerators (capacity > 3 tonnes/hr), and plants emitting over 150 tonnes/year of SO_x, NO_x, hydrochloric acid compounds, or non-methane HC, and solvents/VOC. Revenue from the fee (FF 150/tonne) is used for the pollution abatement and monitoring equipment. (OECD 1995, p. 27; Bernstein 1993, p. 47) Water effluent charges were introduced in 1968 (enacted 1964) on suspended and organic matter discharged in the six river basins; later extended to cover salinity (1973), toxicity (1974), nitrogen and phosphorus (1982), halogenated hydrocarbons, toxic and other metals (1992). The value of the charges, per unit weight of pollutant, are set such that the revenue balances the financial assistance provided (for works of common interest, or research in water related matters). The six water agencies contributed US$ 6 billion to water protection projects during 1982-91, which corresponded to approximately 40% of the total cost. (Cadiou and Duc 1994, p. 139, World Bank 1995, p. 67) There is a tax on waste disposal (landfills and incinerators) at the rate of ECU 2.5/ton, and the revenue is used for treatment and recycling. (OECD 1994, p. 63)
Germany	Water	First river authority (Genossenschaft) was set up in 1904 along the Emschen river in Ruhr valley, to treat industrial wastes in cooperatives funded by effluent charges. By 1975, there were 8 Genossenschaft for 8 rivers, with 500 private and public members, and appr. $60 million annual charge revenue (1975$). Later, wastewater charges were introduced in 1981 in three states (under the 1976 Act), later extended nation-wide in 1983 (and to former East Germany in 1993). The tax, based on population equivalent, cover COD, phosphorus, nitrogen, and some organic compounds and metals. Charges vary across municipalities and across industries. Revenue is used to cover expenses in water quality management, and to subsidize projects which improve water quality. General perception has been that the system helps improve water quality. (Smith 1995, p. 25; Bohm and Russell 1985, p. 403-404; Hahn 1989, p. 105; World Bank 1995, p. 67)
Ireland	Water	Water effluent charges are levied through licenses. Local authorities levy sewage disposal charges. (OECD 1995, p. 41)
Italy	Water	Industrial waste pollution charge system is designed to encourage firms to achieve the standards. Effluent charge on firms who do not meet the standard is ten times that on firms who do. Once full compliance is obtained there will be no charge system. (James 1996, p. 67)

Japan	Air	Emission charges on SO_x, differentiated by regions. The rates are partially based on emissions in the previous year as well as that in 1982-86. The charge revenue is used to compensate for health damages from pollution. (OECD 1994, p. 57-58)
Netherlands	Water	Implemented effluent charges based on the amount of pollutant in 1969-70. With an increase in charge rates during 1975-80, the amount of organic pollution removed from sewage discharges increased from 25% in 1975 to 46% in 1980 (96% of this can be statistically explained by the increase in the charge rates and the differences in the regional structure of the industry). Revenue from the charges (different across districts) financed construction and operation of sewage treatment plants. During 1969-85, pollution (in population equivalent) had registered a 90% decline. (Bressers and Schuddeboom 1994, p. 154-57; Hahn 1989, p. 106)
Portugal	Air, water, land	Emission charges are levied on SOx, NOx and VOCs. The revenue is used for air quality control (OECD 1994, p. 58; EPA 1992, p. 9-2). Households and firms pay water effluent charges based on pollution load. The households, however, pay a flat fee. Hazardous wastes have a charge, and the revenue is used for waste processing. (OECD 1994, p. 58, 65, 68)
Spain	Water	Firms pay water effluent charges based on actual pollution load. The charge is modeled on the French system. (OECD 1994, p. 68-69)
Sweden	Air	NO_x charge on heat and power producers implemented in January 1992 (excluding industrial process burning), with a capacity exceeding 10MW and producing over 50 GwH. Where emissions cannot be measured, standard emission rates are used: the rates being greater than the average actual emissions, it has encouraged installation of measurement equipment. In 1992 a 30-40% emission reduction was achieved. All revenue is rebated to installation (subject to a charge) based on firms' final energy production. The final revenue impact is zero, but there is redistribution between high emitting and low emitting plants. (OECD 1994, p. 59)
Switzerland	Air	Tax on VOCs was scheduled to be introduced in 1995-96 and expected to rise over time to ECU 3/kilo. It is aimed to reduce smog, ozone problems, and damage to the nerve system. (OECD 1995, p. 15)
Turkey	Water, land	Since 1994, a tax on waste and waste water has been levied on households and firms. The charge is aimed at reducing pollution as also raising revenue. (OECD 1995, p. 14)

UK	Water	Discharge consent (maximum permitted emissions) charges are administered by the National Rivers Authority since 1990. Charges vary according to the content and destination of effluents; and are designed to cover the recurring cost of monitoring effluents and controlled waters. (Smith 1995, p. 32)
US	Air, water, land	Excise tax imposed on each pound of ozone-depleting chemicals (CFCs, halons, carbon tetrachloride, and methyl chloroform) came into effect in 1991. The tax for a specific chemical is determined by its ozone-depleting factor with a base amount for the tax. Since the tax is imposed along with quantity restrictions, it serves to capture part of the profits accruing to those in control of the limited supplies of these chemicals. The tax revenue from ozone-depleting chemicals was $886 million in 1991, and $580 in 1992. (Oates 1994, p. 114; OECD 1995, p. 89) Some states have flat fees for waste water discharge, which does not provide incentive to reduce the volume of waste but deters entry into the activity. During 1972-77, industrial discharges from point sources fell by 70%, and the quantity of oxygen demanding pollutants emitted by municipal treatment plants fell by 46%, despite a 12% rise in pollutants entering these plants. Problems remain with non-point sources and contamination of ground water. Few states have non-uniform fees: New Jersey impose fees based on the quantity and relative risk (to public health) of the pollutants; California has a waste water discharge permit fee based on type and volume of the discharged pollutants. The charge revenue fund environmental programmes. (James 1996, p. 61-62; and Oates 1994, p. 120) Excise taxes (Superfund tax) on hazardous chemicals are also in force. The revenue is used to clean up contaminated sites: in 1992, the revenue from this tax was $254 million. (OECD 1995, p. 98; OECD 1994 p. 65)
2. Tradeable permits		
Australia (states)	Water	The states of New South Wales, Victoria, and South Australia participate in the Murray Darling Basin Salinity and Drainage System to control the amount of salt entering the river system. The system works through transferable "salt credits" which are tradable across states, but not across firms and individuals. (OECD 1994, p. 89)
Canada	Air	Emission trades cover acid rain pollutants (SOx, NOx) and CFCs. In Ontario, the electric utility of Ontario Hydro is allowed to shift or "trade" SOx and NOx emissions between its electricity generating stations. Internal trading of CFCs are also allowed, subject to the legislation. (OECD 1994, p. 89)

Germany	Air	New plant emissions (of substances subject to the "TA Luft") have to be offset by reduction in emissions from older existing plants, such that the net effect on ambient air quality is neutral. However, the offset and netting provisions in the air pollution regulation are rarely used, since the areas over which the emissions can be traded are small, and substitution between substances is not allowed. Also in many cases, there are increasing returns to scale and indivisibilities in the abatement costs, such that firms have little freedom to choose between emission levels. Consequently potential trades among sources are small. (OECD 1994, p. 89-90)
Singapore	Air	In 1990, introduced a marketable permits system for rights to import ozone-depleting substances (CFCs under the Montreal Protocol) and to own motor vehicles ("certificates of entitlement"). For CFCs, half the quotas are grandfathered and half are allocated through sealed bid tenders. The auction allows the government to capture a substantial portion of the quota rents, which have been used to subsidize recycling services and diffusion of alternative technology. By mid-1992, the vehicle quota premium for standard cars rose to US$ 12,000. This and complementary policies (eg. ALS) restricted the growth in car ownership and traffic. (O'Connor 1995, p. 16-17)
US (states)	Air, water	Emissions trading was introduced in 1974 (netting), and enhanced over the years to include more types of transactions (bubbles, banking, offsets). Pollutants covered include VOC, CO, SO_2, NO_x, particulates, and CFCs. By 1986, 7,000-14,000 internal trades, and some 200 inter-firm trades had taken place: the abatement cost savings, $935-$12,435 millions, though substantial, was less than expected. Trade in lead credits, to phase out lead in gasoline in 1982-87, performed better. Interrefinery trading did not discriminate between old/new sources, nor between large/small sources. In 1985, about 15% of the total lead credits in use were traded. In the production and consumption of CFCs, a 50% reduction had been achieved by 1993. Southern California introduced RECLAIM (Regional Clean Air Incentives Market) programme in 1994, and is aimed to reduce NOx and SOx emissions from all major stationary sources by 75% and 60% respectively from 1994 by the year 2010. Smaller sources can voluntarily enter the programme. The RECLAIM trading credits, each valid for a year, have been transacted both bilaterally within firms and through auctions. RECLAIM is expected to reduce control costs by 42% on an average compared to the CAC option for the large firms. (Hahn 1989, p. 99-102; OECD 1994, p. 87-88; CSE 1996, p. 22-23) Tradeable water pollution rights have been implemented in Colorado (Dillon and Cherry Creek Reservoir), Wisconsin (Fox River) and North Carolina (Tar-Pimlico Basin). Wisconsin implemented marketable discharge permits on part of the Fox river in 1981 to control BOD level. Each permit defined wasteload over 5 years, for 10 pulp and paper firms, and 4 municipal waste treatment plants. Till date there has been only one trade, due to the thin market. In Colorado, tradeable rights to discharge phosphorous into the Dillon Reservoir was introduced by the local government . By 1992, there were applications but no trade had been approved. (OECD 1994, p. 89; Hahn 1989, 97; Cropper & Oates 1992, p. 691)

3. Deposit refund

Australia	Land	There is a mandatory deposit-refund scheme for PET bottles and disposable beverage glass bottles. The deposit is about 2-5% of the price, and the return rate achieved for PET bottles is 62%. Beverage metal cans have a deposit of 4-5% of the price, and the return rate is 89%. (OECD 1994, p. 83-85)
Austria	Land	Mandatory scheme for plastic reusable containers, and voluntary deposit refund for beverage glass bottles. The deposit for reusable plastic containers is 20% of the price, and the return rates achieved are 60-80%. (OECD 1994, p. 84)
Belgium	Land	The deposit refund scheme covers beer and soft drinks glass containers. (OECD 1994, p. 85)
Canada	Land	Mandatory deposit refund scheme for plastic beverage containers, and alcoholic drinks glass bottles (sometimes voluntary) in some regions. The return rate for these is more than 60%. For metal cans the return rate is greater than 40%. (OECD 1994, p. 83-85)
Denmark	Land	All soft drinks and beers can be sold only in reusable bottles for which the consumer needs to pay a deposit, according to a statutory order of the Ministry of Environment. PET bottles have a return rate of 80-90%, and beverage glass bottles have a return rate of 90-100%. (Bernstein 1993, p. 55; OECD 1994, p. 84-85)
Finland	Land	Under the deposit-refund scheme of beverage glass containers, a 90-100% return rate has been achieved. PET bottles have a deposit of 10-30% of the price and the return rate is 90-100%. (World Bank 1995, p. 71; Bernstein 1993, p. 55; OECD 1994, p. 84-85)
France	Land	There is a deposit-refund system for beer and soft drink glass bottles. (OECD 1994, p. 85)
Germany	Land	Voluntary deposit-refund scheme for alcoholic- and soft drink glass bottles has a return rate of 90-100%. There is also a scheme for non-refillable plastic bottles. (OECD 1994, p. 84-85)
Greece	Land	Mandatory deposit-refund on car hulks older than 15 years. The system is combined with a tax differentiation, and the refund is payable only if a new car is bought that satisfies EC-emission standards. (OECD 1994, p. 83)

Iceland	Land	Mandatory deposit-refund scheme for plastic and glass (alcoholic beverages, mineral water) bottles. The deposit for plastic bottles is 3-10% of the price, with a return rate of 60-80%. For the mineral water glass bottles the deposit is 18-20% of the price with a return rate of 60-80%. (OECD 1994, p. 85)
Japan	Land	Under the voluntary deposit-refund system, the collection rate of beer bottles in 1989 was 92%. By 1990, recycling rates for waste paper, aluminium cans, steel cans and glass bottles were 49.7%, 42.6%, 44.8% and 47.9% respectively. (O'Connor 1994, p. 44-45)
Netherlands	Land	Voluntary deposit-refund scheme for beer, soft drink and milk glass bottles. The deposits range from 37-45% of price for soft drink glass bottles and 20-50% of price for milk/dairy products bottles. The return rates for beer bottles is 99%, and for soft drink bottles 95-98%. PET bottles have a deposit of 30-50% of the price, and the return rate is 90-100% (OECD 1994, p. 84-85)
Norway	Land	Introduced mandatory deposit-refund system for car hulks in 1978: new car buyers pay a deposit and a larger amount is refunded on return to an official recovery site. Almost 90-99% of car hulks are returned, and the revenues are used for refunds and financial assistance for collection, transportation, and scrapping facilities. (OECD 1992, p. 9; World Bank 1995, p. 71; Bernstein 1993, p. 55). There is mandatory scheme for PET bottles, with a return rate of 90-100%. Glass bottles (beer, carbonated drinks) have deposits ranging from 10-20% with a return rate of 90-100%. Wine and liquor glass bottles have a deposit of less than 2% and the return rate is 40-60%. (OECD 1994, p. 85)
Portugal	Land	Voluntary deposit-refund schemes cover metal and plastic containers, and beverage glass bottles. (OECD 1994, p. 83-85)
Sweden	Land	Mandatory deposit-refund for car hulks, PET-bottles, glass bottles, and voluntary for aluminium cans. The return rates of these are 80-100%. On doubling the deposit charge for aluminum beer cans, the return rate increased from 70% to over 80% (the system is operated by a private company). (OECD 1994, p. 83-85; World Bank 1995, p. 72)
Switzerland	Land	Mandatory deposit-refund scheme for beverage glass bottles. (OECD 1994, p. 85)
Turkey	Land	Deposit-refund system for glass bottles. (OECD 1994, p. 85)

US	Land	Ten states have mandatory deposits on soft drinks and beer plastic/ glass containers (although in use earlier, states "reintroduced" the measures, e.g. Oregon in 1972). A refund of 5 to 10 cents has created enough incentive to achieve a return rate of 80-95%. Studies indicate that such schemes have reduced the volume of beverage container litter by 79-83%, and the volume and weight of overall solid waste by 8% and 6% respectively. (Oates 1994, p. 119; World Bank 1995, p. 71; OECD 1994, p. 84-85) In Rhode Island, US, automobile batteries have a mandatory deposit of $5, paid at the time of sale. The dealers hold the deposit (returned if a used battery is returned within seven days of purchase), and are required to return 80% of the deposit funds they hold to the state. The system is considered to be a success. The state of Maine has a mandatory deposit system for pesticide containers: $5 for containers less than 30 gallon capacity, and $10 for larger containers. The deposit is refunded when the triple rinsed container is returned. (Bernstein 1993, p. 56)

TABLE 1B. INDIRECT INSTRUMENTS (Developed Countries)

4. Input/output tax and differential tax rates

Australia	Air	There has been an increase in petrol taxes, and the price differential between leaded and unleaded petrol in favour of the latter. (OECD 1995, p. 14)
Austria	Air, water	Introduced an environmental tax on car registration in 1992, based on price of new cars and its average petrol consumption. Simultaneously, the VAT rate on new vehicles was reduced. (OECD 1995, p. 23) Tax on fertilizer and pesticide since 1985-86. The revenue is used for environmental expenditure. In the first year their use declined by 10%, and by another 20% in 1987-88. (Pearce 1991, p. 54; US GAO Report 1993, p. 13; OECD 1994, p. 75-76)
Belgium	Land	Tax on disposable-razors/ cameras, and some drink containers which cannot be reused/recycled. Cars not satisfying the emission standards also have higher tax rates. (OECD 1995, p. 14, 70)

Britain	Air	Various vehicle taxes including: sales tax on new cars (17.5%), and annual vehicle excise duty. The taxes on commercial vehicle sales, ownership (vehicle excise duty is based on number of axles and weight) and use are higher and more complex than taxes on private cars. Tax differential between leaded and unleaded petrol has increased over time and now stands at 4.8 pence per litre. The proportion of unleaded in total petrol sales rose to 50% in 1993 compared to negligible share in 1986. The marginal saving in buying unleaded vs leaded petrol outweighed the fixed costs of converting cars to run on unleaded petrol for all except those doing few miles/year. (Smith 1995, p. 96, 109; McKay, et al. 1990, p. 13)
Canada (provinces)	Land	British Columbia has a tax of C$5 per lead acid battery; Ontario and Manitoba have charges on non-refillable beverage containers; and some provinces have charges on tires. Leaded petrol has been phased out since December 1990. (OECD 1995, p. 86; OECD 1994, p. 72)
Denmark	Air, land	In 1992, a fuel tax was introduced based on CO_2 content at combustion. About 50% of the CO_2 tax was reimbursed to businesses (registered under the VAT law), but not that on diesel used for motor fuels. Aviation, shipping, and gas consumption on refineries are exempt from the CO_2 taxes. Since the mid-1980s, leaded and unleaded gasoline have had differential tax rates. In 1994, the market share of unleaded petrol was nearly 100%. (OECD 1995, p. 27-28) New tax on plastic/paper shopping bags of DKr 0.5/bag, following the 1994 tax reform. (OECD 1995, p. 14)
Finland	Air, water, land	Environmental taxes on cars, based on whether or not they are equipped with a catalytic converter. Tax differentiation in favour of lead-free petrol was introduced in 1986. By 1992, the market share of unleaded petrol was 70%. Since 1993, excise tax on diesel favours sulphur-free diesel fuel. In 1994, an EU-type of carbon/energy tax was imposed on fuels as a revision of the 1990 carbon tax. (OECD 1994, p. 72; OECD 1995, p. 15, 23, 30) Product charge on fertilizers. (EPA 1992, p. 9-3; OECD 1994, p. 75-76)) Charge on non-returnable bottles and containers. (McKay, et al. 1990, p. 12)
France	Land	Product charges on lubricants on the manufacturers and importers. The charge is complemented with regulations on collection, storage and disposal of used oil; and the revenue is used for providing assistance in developing infrastructure of those three functions. The charge being low, the incentive impacts have been insignificant. (Bernstein 1993, p. 59)

Germany	Air, land	Annual motor vehicle tax is structured so as to provide tax incentives to cars meeting the EU emission standards. Rates are differentiated by age of the car. Since 1994, diesel-engine cars face an additional tax compared to the petrol cars. The duty differential between leaded and unleaded petrol is DM 0.10 per litre: the market share of unleaded in total petrol sales rose from 11% in 1989 to 80% by 1993. (Smith 1995, p. 96, 109). In 1992, the city of Kassel introduced a tax on disposable plates, cutlery, and packaging for take-away food/drink. Such taxes by municipalities are allowed so long as the federal government does not have similar taxes. (Smith 1995, p. 67)
Greece	Air	A 1990 law provided exemption from the road surtax and the initial lump sum tax for five years for new cars fitted with a catalytic converter. Exemption was given when the buyer had scrapped his old car. About 300,000 old cars were scrapped and pollution considerably reduced. (OECD 1995, p. 23)
Iceland	Land	Tax on plastic bags, at the rate of 8 IKr/bag. (OECD 1995, p. 88)
Ireland	Air	The excise duty on leaded petrol is higher than that on the unleaded petrol. (OECD 1995, p. 51)
Italy	Land	A product charge on lubricant oils (due to a 1975 EC directive on recycling of waste oils). Waste oils collected increased from 55,000 tons in 1985 to 105,000 tons in 1986 (OECD 1992, p. 9). Vehicle batteries and other batteries are subject to a charge, and the revenue funds the collection of used batteries. In 1988 a tax of 200% was levied on plastic shopping bags, and the consumption of plastic bag immediately fell by 20-30%. The tax on plastic carrier bags was, however, abolished in 1994 and replaced with a recycling contribution on virgin polyethylene. (EPA 1992, p. 9-3; OECD 1994, p. 82; OECD 1995, p. 14)
Luxembourg	Air	Excise and VAT tax rates are higher on leaded petrol than on unleaded petrol by margin of 2-3%. (OECD 1995, p. 52)
Japan	Air	Tax deductions are available for cars with low emissions, electric cars and cars on alternative fuels. (OECD 1994, p. 70)
Netherlands	Air	In 1988, environmental charges were introduced on fuels, and in 1990, a carbon (CO_2) component was added to the tax base. Sales tax on cars that complied with future European standards was reduced, and raised for the dirtier models.

		In the 1980s, in the small car market (two-thirds of the market), the percentage of future European standard cars increased from 37% to 70%. Unleaded petrol was made cheaper than leaded petrol, and within two months unleaded petrol completely replaced the normal petrol in service station forecourts. The carbon tax on motor fuels is too low for significant incentive effects, its revenue funds government environmental investments. (Bressers and Schuddeboom 1994, p. 156; OECD 1994, p. 73; OECD 1995, p. 31; World Bank 1995, p. 68)
New Zealand	Air	A fee is levied on lead added to gasoline (NZ$0.066 = $0.039 per gram). In effect it is preferential tax treatment of unleaded over leaded petrol. (EPA 1992, 9-3)
Norway	Air, water, land	Taxes are based on the sulphur, carbon and lead content of fossil fuels. The CO_2 tax was introduced in 1991. The CO_2 tax revenue represents an important element of the national budget, e.g. in 1994 contributed 6 billion NKr to state revenues. Since 1986, the basic petrol tax differentiates between leaded and unleaded petrol. In 1995, rate differential was introduced for leaded petrol based on the emissions of lead per litre. (Bernstein 1993, p. 49; OECD 1995, p. 33) Charge on disposable beverage containers since 1988. Also charges on non-refundable containers, batteries, lubricating oil, fertilizer, and pesticides. (OECD 1995, p. 88; World Bank 1995, p. 68; McKay, et al. 1990, p. 12)
Portugal	Air	The tax differential in favour of unleaded petrol is being phased out, since unleaded petrol sales as a proportion of total petrol sales are about the EU average. There are taxes on batteries, packaging, glass, plastic, coal ash, mining and tires. (OECD 1995, p. 15, 89)
Singapore	Air	Imposed large "additional registration tax" (besides the flat registration fee) levied as a percentage of the cost of the car to restrict ownership (thereby traffic congestion): 100% in 1976, and 150% after 1983. The tax is reduced if an old vehicle is scrapped when a new one is purchased (to discourage older, more polluting vehicles). (Buchan 1994, p. 226)
Sweden	Air, water, land	Product taxes on all fossil fuels since 1991. In 1993, gasoline tax revenue was more than 40% of environmental taxes (latter constituted 6% of total tax revenue). With a tax differential of 0.51SEK/l between leaded and unleaded gasoline in 1993, the consumption of leaded fuel was reduced to less than half of the total gasoline consumption. In 1991, diesel was classified in to 3 categories by pollution potential, and a special diesel fuel tax differentiated by type of diesel was levied. Other energy taxes include carbon tax, sulphur-in-fuel tax, nuclear and hydro power tax. Energy and CO_2 tax is so high that some district heating plants are changing from fossil fuels to bio fuels. Sulphur content of oil fell by about 30% in 1990-92 as a result of the sulphur tax (the accompanying administrative costs were approximately 1% of the revenue).

		Vehicle taxes (sales and annual taxes) are based on weight and environmental characteristics. Special tax on cars without catalytic converters, and subsidy on new cars with catalytic converters succeeded in introducing low-pollution vehicles at a rate faster than the normal rate. (Sterner & Lowgren 1994, p. 54-56; OECD 1994, p. 73-74; Bergman 1994, p. 254; OECD 1995, p. 15, 24, 34-35; Bernstein 1993, p. 49) Charges on non-refundable containers, batteries, lubricating oil, fertilizer, and pesticide. The charge revenue from fertilizers is used for environmental expenditure. The charge on beverage containers, levied in 1973, was abolished in May 1993. (World Bank 1995, p. 68; OECD 1994, p. 75-76; OECD 1995, p. 89)
Switzerland	Air	With a tax differentiation of ECU 0.04/l in favour of unleaded petrol over leaded, the market share of unleaded was 65% in 1992. (OECD 1994, p. 72)
US	Air, water	The federal gasoline tax introduced in 1932, although some states had such a tax as early as 1919 (Oregon). Gasoline tax served as the most important source of revenue for states in 1930s and 1940s. The revenue is mostly earmarked for transportation programmes (road/ highway construction/ maintenance). Federal taxes on motor vehicles include: a 12% manufacturers excise tax on trucks and trailers, annual use tax on"heavy vehicles" like trucks, excise tax on tires weighing over 40 pounds, and a "Gas Guzzler" tax on automobiles with unsatisfactory fuel economy ratings. States have a range of auto taxes and fees. In 1989, state motor vehicle and license fees revenue was $10.15 billion. (Oates 1994, p. 114-115) Revenue from the charge on fertilizers is used on environmental expenditure. (OECD 1994, p. 75-76)

5. User and administrative charge

Australia	Water, land	Households and firms pay user charges for sewerage and sewage treatment (flat rates and measurement based rates exist). State of New South Wales levied an environmental charge in 1989-90 (for 5 years) on water and sewage facilities. The charge revenue was earmarked for a programme of environmental measures. Waste disposal and management charges based on weight and volume are levied by State and local governments. (OECD 1994, p. 67; OECD 1995, p. 41, 95)
Austria	Water	User charge on municipal waste. (OECD 1994, p. 62)
Belgium	Water, land	Households pay charges for sewerage and sewage treatment based on water use. Federal charges on export/ import/ transit of wastes, and toxic wastes. Local charges on waste disposal and management. Households pay a flat rate (and sometimes based on actual measurement) on municipal waste collection. (OECD 1995, p. 95; OECD 1994, p. 62, 67)

Canada	Water, land	The domestic sewage charge is calculated on the basis of residential property values or consumption. A flat residential sewage tax is also used. Households also pay user charges (flat as well as measurement based) on collection and disposal of municipal waste. (Bernstein 1993, p. 33; OECD 1994, p. 62)
Denmark	Water, land	User charge for sewerage and sewage treatment based on water use (and excess pollution load for firms): Households pay a flat fee, while firms are charged according to actual measurement. Excise duty on waste delivered to landfill sites and incineration plants. (OECD 1994, p. 67; OECD 1995, p. 95)
Finland	Water	State imposes a water protection charge on heavy polluters, and the revenue is earmarked for water protection activities of the state. There are municipal waste water charges based on actual measurement and the revenue is spent on collection and disposal. Households and firms also pay for sewerage and sewage treatment, based on water usage (and excess pollution load in case of firms). (OECD 1995, p. 41; OECD 1994, p. 62, 67)
France	Land	In 1992, a tax was introduced on dumping of waste, the goal being to phase out all traditional refuse dumps by the year 2002. (OECD 1995, p. 96)
Germany	Water, land	Sewerage service charges are usually based on water consumption. In 1993 the average rate per cubic metre was about DM 2.70. Household waste collection and disposal charges, levied by municipalities, are based on bin size and frequency of collection. The difference in charge rate for bin size is relatively small, providing no incentive to reduce volume of waste. Some states (Nordrhein-Westfalen, Rhineland-Pfalz, Baden-Wurttemberg, and Saarland) are experimenting with volume- and weight-based charges. There are also hazardous waste disposal charges. The municipal waste charge for firms is based on the actual measured waste. (Smith 1995, p. 44, 64; OECD 1995, p. 96; OECD 1994, p. 62)
Iceland	Land	Households pay a flat municipal user charge for waste collection and disposal. The charge rate, however, varies in different localities. (OECD 1994, p. 64; OECD 2995, p. 97)
Ireland	Water	Sewage disposal charges are levied by local authorities. There are also charges on licences for water emissions. (OECD 1995, p. 41)
Italy	Land	Domestic refuse disposal charge, based on the use of the surface. In 1994, the charge revenue was L 420.9 billion. (OECD 1995, p. 97)

Japan	Land	Households pay municipal waste charges for collection and disposal. While there is a flat rate in most municipalities, some base the charge on actual measurement. (OECD 1994, p. 62)
Netherlands	Land	Charges on domestic refuse disposal, dumping wastes at landfill sites, and municipal waste management. In 1995, the charge revenue was estimated to be over 4,000 million Gld. (OECD 1995, p. 97; OECD 1994, p. 62)
Norway	Air, water, land	In 1986, the city of Bergen, Norway, introduced a toll system for motorists entering the city between 6 am to 10 pm on weekdays, to reduce congestion and pollution. The rate is differentiated by the loading capacity of vehicles. The system can be improved by designing higher tolls for the peak hours only. The toll revenue collected (56 million Nkr in 1986, 59 million Nkr in 1988) is used to finance the construction of by-passes through the surrounding mountains in order to keep the long-distance traffic away from the city centre. After the by-passes are completed, the tolls will be removed. (Henry 1990, p. 261). Household pay a flat user fee for sewerage/ sewage treatment (based on water usage) and municipal waste. While firms pay for sewage treatment based on water usage and excess pollution load, municipal waste charges are based on actual measurement. The municipal waste charge revenue is used in collection and disposal of waste. (OECD 1994, p. 62, 67)
Portugal	Water	Waste disposal in sewerage system are subject to municipal charges. Waste water disposal in the natural environment is also subject to charges, based on the pollutant. (OECD 1995, p. 98; OECD 1994, p. 67)
Singapore	Air	Implemented the Area Licensing Scheme (ALS) to reduce traffic congestion in 1975. A vehicle entering the restricted zone (encompassing 620 hectares) required a licence ticket on a daily/monthly basis for the peak hours. By 1989, the fee was highest for company cars, less for private cars/taxis, and least for motorcycles. The fine for non-compliance was about ten times the daily licence price. In 1988, the average violations/day was 100, while the number of licences/day issued was 12,000. The restricted zone also has higher parking fees, and strict enforcement at 28 points of entry to the zone. Although car traffic rose after 1977, private car traffic was 64% below the pre-ALS flows by 1982 in the peak hours, despite the growth in income and employment. Complemented with other policies, ALS helped reduce the smoke and acidity in the city air. (Buchan 1994, p. 220, World Bank 1995, p. 69; Bernstein 1993, p. 48)
Spain	Water, land	Households and firms pay a flat fee for municipal waste, and a sewerage charge based on water usage (actual measurement). The municipal waste charge revenue is used for collection and disposal. (OECD 1994, p. 62, 67)

Sweden	Water, land	Municipal charge a two-part tariff for treatment of sewage water: a fixed fee, and a variable charge based on consumption. A growing number of households and small industries are attached to the sewer system and water treatment facilities. Apparently industries have an incentive to reduce water use when extending or renewing their plants. Households and firms pay a flat fee for municipal waste collection and disposal. (Bernstein 1993, p. 33; OECD 1994, p. 62, 67)
Switzerland	Water, land	Households and firms typically pay a flat fee for sewage treatment and for municipal waste collection and disposal. Some municipalities, however, base the charge on actual measurement. Sewage fees can also be based on actual water usage. (OECD 1994, p. 62, 67)
Turkey (cities)	Water, land	Izmir and Istanbul, Turkey, have industrial sewer charges. Since the charges are low, they encourage excessive pretreatment and not enough full treatment plants. (Bernstein 1993, p. 33) In 1994, a solid- and water-waste charge was introduced at the municipality level. (OECD 1995, p. 98)
UK	Water, land	User fees for sewerage and sewage treatment are levied on households and firms, based on water usage (and pollution load for firms). A new tax on waste disposal in landfill sites was announced in 1995 (to be effective 1996). The charge is aimed at reducing waste and to recover more value from the waste produced. Firms have a municipal waste collection and disposal charge based on actual measurement. (OECD 1995, p. 14; OECD 1994, p. 62, 67)
US (local)	Water, land	Households and firms pay user fees for sewerage and sewage treatment based on water usage (and pollution load for firms). Some communities have municipal fees for waste services, based on the amount of refuse discarded (number of containers), or type of waste (collection bags marked by stickers). In 1988, Seattle, Washington, implemented a variable garbage rates scheme, and in January 1989 the monthly waste collection fell by 30% compared to 1988. However, the policy encourages illegal dumping of refuse to avoid the fee. New Jersey, Pennsylvania and Illinois introduced a pay-per-bag system, which has helped to reduce waste. (OECD 1994, p. 67; World Bank 1995, p. 69; Bernstein 1993, p. 55)

6. Subsidies for abatement inputs

Australia	Air, water, land	Deductions for capital expenditures incurred after 18 August 1992 for preventing/ combating/ recycling pollution, or treating/ cleaning up/ removing/ storing waste. (OECD 1995, p. 90)

Austria	Air, water, land	Capital tax exemption for investments in the environmental field. For households, expenditures on energy saving measures are deductible from the tax base (with certain limitations). (OECD 1995, p. 90)
Canada	Air, water	Accelerated depreciation or capital cost allowances for investments in air and water pollution control at sites operating before 1974. Accelerated depreciation is also there for energy saving equipment. (OECD 1995, p. 90)
Germany	Water	Since 1987, a discharger building a treatment plant that reduces effluents to under 50% of the recognized technical rule, can offset half the cost of the investment against effluent charges in the year of construction and the two subsequent years. Similarly, when planning to build a water treatment plant that will reduce effluents by at least 20%, the operator can get a corresponding proportionate cut in charges for the three years prior to building the plant. (Smith 1995, p. 28)
Finland	Air, water	Accelerated depreciation at maximum of 25% of purchase price annually for four years is allowed for investments in air and water pollution control equipment. (OECD 1995, p. 91)
France	Air, water	Accelerated depreciation is allowed for pollution reducing equipment covering: industrial water treatment plants, air cleaning facilities and electrical vehicles. Air pollution charge revenues were returned to the polluters as a subsidy for installing abatement equipment. (OECD 1995, p. 91; Tietenberg 1991, p. 91)
Ireland	Air, water	Accelerated depreciation, and tax exemptions are available for expenditures on pollution abatement, and business contributions to local authority expenditure on effluent control. (OECD 1995, p. 91)
Japan	Air, water, land	Special initial depreciation as a percentage of the acquisition cost, in addition to ordinary depreciation, for pollution preventing/ recycling equipment, and for energy efficiency improving technology. Air, water, and noise abatement facilities get reductions of income, corporate, municipal and fixed property taxes. Asbestos emission reduction facilities are exempt from municipal and fixed property taxes. (OECD 1995, p. 91)
Netherlands	Air, water, land	Since September 1991, accelerated depreciation is allowed for investment in pollution prevention equipment. Subsidies were offered to remove heavy metal in effluents and remove PCBs from ceratin products in 1980s. The subsidy on water effluent treatment probably improved the relations between the water management and the industry, and enhanced the effectiveness of other policy instruments like charges. 72% of all PCBs were replaced during 1984-89: but the subsidy scheme may account for only 32% of this reduction. (OECD 1995, p. 92; Bressers and Schuddeboom 1994, p. 154)

Norway	Air, water	Industrial investments to reduce air and water emissions, and to handle municipal wastes, are exempt from the usual 7% investment duty. (OECD 1995, p. 92)
Portugal	Air, water	Reduction of charge and subsidies granted on a case by case basis for investments relating to environmental protection of air and water. Expenditures on renewable energy forms are eligible for tax benefits. (OECD 1995, p. 92)
Sweden	Air	System of tax rebate for producers of cleaner diesel fuel since 1991 (two types of clean diesel were distinguished from the standard diesel). In early 1993, about 75% (compared to 1% in 1990) of the total diesel sales constituted of the cleaner types of diesel, and only 25% of the standard variety. (Bergman 1994, p. 255)
US	Land	As of 1991, 23 states have fiscal incentives for recycling: tax credits/deductions for investment in recycling equipment, sales tax exemptions on recycling machinery, and various loans/grants for related activity. (Oates 1994, p. 119)

7. Enforcement incentive (performance bonds and non-compliance fee)

Australia (regions)	Water, land	Performance bonds are applied on obligation to rehabilitate landscape after mining, and on feedlots and marine environment protection. In the latter case, the bonds are proportional to expected damage. (OECD 1994, p. 91)
Canada	Air, water, land	Non-compliance fees are levied for violation of environmental protection norms, and are proportional to the estimated monetary benefits. Some regions have security deposits (performance bond) for resource exploration and land reclamation. The deposit is proportional to the amount of land distributed and cost of rehabilitation. (OECD 1994, p. 91)
Germany	Water	Dischargers meeting or exceeding the mandatory standards pay only half the normal rate of effluent fees. (Tietenberg 1991, p. 90)
Italy	Water	The effluent charge on non-complying firms is nine times higher than for firms who meet the prescribed standards. The system was scheduled to expire after full compliance had been achieved. (Tietenberg 1991, p. 91)
Japan	Air, water	Fines to compensate victims of environmental pollution (1974 legislation), for specific diseases (Minimata, Itai-Itai, air pollution-related asthma. After the environmental quality improved, the government stopped considering new compensation claims. (James 1996, p. 69; Tietenberg 1991, p. 91)

Sweden	Air, water	Penalty fees are applied to discharges from oil ships, based on the tonnage of discharge. Environmental protection charges are levied based on the non-compliance benefits. (OECD 1994, p. 91)
Turkey (cities)	Water	Izmir and Istanbul, Turkey, have penalty system for non-compliance with environmental standards applied to several industrial polluters. The financial fines have not provided adequate incentive effects since companies often litigate to delay or avoid payment. However, the threat of closure by the municipality has worked better. (Bernstein 1993, p. 35)
US	Air, land	Non-compliance fees on facilities that violate norms in the Clean Air Act in installation/operation of air pollution equipment. The two-part fine consists of: first, the computed economic gain from no-compliance, and second, a fine upto US $25,000/day for the period of violation before detection. Non-conformance charge on heavy vehicles and engines are based on the degree of non-compliance. Firms can also be liable for any damage caused from the pollution. Penalty fees are levied for release of hazardous waste, based on the damage inflicted. (World Bank 1995, p. 72; Bernstein 1993, p. 42; OECD 1994, p. 91)

8. Suasive instrument

Denmark	Air	Dansk Industri (an industry association) agreed to undertake measures to cut down on VOCs (chemicals used widely in solvents, paints, etc) after discussions with the Environmental Protection Agency (the original objective being to cut down VOC emissions by 30% by the year 2000 from the 1988 levels). (Wallace 1995, p. 30-31)
Germany	Land	Waste collection and disposal system, Duales System Deutschland GmbH, was set up by large retailers and packaging firms in 1992 (following a federal ordinance in 1991 which makes the manufacturer of a particular product responsible for its whole life cycle until its final disposal). Participation in the dual system ("green dot" products) is voluntary. Since 1992, the overall use of primary and secondary packing fell by appr. 10%, with the most significant reduction in the use of glass and plastics. (Smith 1995, p.71-72)

Japan	Air, water, land	Voluntary agreements on pollution control between the industry and government/local community started in the 1950s. The amendment of the 1967 Basic Law for Environmental Polltion Control in 1993, makes the relationship between industry and government more transparent (Article 8 states that "*corporations are responsible for making voluntary efforts to conserve the environment such as reduction of environmental loads in the course oftheir business activities*"). Local government bodies have considerable autonomy and play a major role in balancing the community and industry interests in environmental management. e.g. The Tokyo Metropolitan Authority recommends specific pollution control and draws up voluntary contractual agreements with companies involved in large scale developments tailored to specific pollution control. At the national level the MITI is responsible for the programme of voluntary measures by the industry, and builds on the existing relationship between local authorities and the industry. By 1991 there were about 37, 000 pollution prevention agreements in effect, some involving citizen participation. (Wallace 1995, p. 104; James 1996, p. 69; Murty 1996c, p. 39)
Netherlands	Air, water, land	The National Environmental Policy Plan (NEPP) identifies ten target groups (agriculture, transport, industry, energy, waste processing, water supply, societal organizations, consumers, etc), and each group is expected to make voluntarily work towards the major NEPP goals. By the end of 1993, about 15 voluntary agreements had been made by different groups. (Wallace 1995, p. 47-49)
US	Air, water, land	The US EPA's Toxic Release Inventory (TRI), following the 1986 Emergency Planning and Community Right-to-Know Act, is a data base of estimated annual releases of all the chemicals reported by the industries. The EPA collects the data, compiles and makes it available to the public through various formats. The US General Accounting Office estimated that following the inventory programme, over half of all the reporting facilities made one or more operational changes designed to reduce toxic emissions. The second information-based incentive is provided by "environmental/ green labelling", where private or public bodies evaluate environmental impacts of consumer products and issue seals of approval for products that meet certain standards. (US GAO Report 1993, p. 11-12)

TABLE 2A: DIRECT INSTRUMENTS (Developing Countries)

1. Pollution charges

Country	*Medium*	*Description*
Brazil (3 states)	Water	Sao Paulo introduced a charge (sewerage tariff) based on pollution content (not volume) in 1983. This was partially implemented across regions by the sanitation company as a payment for sewerage treatment services. The states of Rio de Janeiro and Parana also have such industrial sewerage tariffs. The charges cover the costs of public water treatment. (Margulis 1994, p. 112; World Bank 1995, p. 66)
China	Air, water	In 1991, air discharge permits were introduced on a pilot basis for *large* firms in 16 cities, and covered 57 cities by 1995. A water discharge permit system for large firms was introduced in 1987 on a trial basis in 17 cities, and by 1995 was extended to 391 cities. The discharge licenses specify both the pollutant concentration and a factory's maximum annual wastewater discharge volume. The trial systems try to address the regional differences in abatement costs and assimilative capacities of local environments. In 1993, a volume-based industrial waste water charge was introduced, at the rate of 0.05 yuan/ton. The firms, however, are not required to pay both an overstandard pollution fee (non-compliance charge) and within standard pollution charge: the non-compliance fee supersedes the wastewater discharge fee when effluent standards are violated. In 1993, the collection from the within standard charge was about 10% of the collections of the overstandard fee. The charges are not indexed to inflation, and in 1993 the average annual fee (penalty plus pollution charge) per paying firm was less than 0.1% of the firm's total output value on average. However, conflicting incentives arise where, the non-compliance fee is applied simultaneously with charges or taxes. Earlier, some enterprises used to shield profits from taxes by paying into the charge system and then recovering 80% of their payments under a rebate programme. (Florig, et al. 1995)
Estonia	Air, water	In 1991, charges were introduced on emissions from stationary sources (stacks, municipal boilers etc) covering approximately 50 pollutants. The tax rate is based on volume and toxicity of emissions, as well as the size of the polluted area and the type of land use in the area affected (eg. whether land use is rural/ industrial/ recreational/urban residential). However, the rates are too low to have adequate incentive effect for pollution abatement, and the revenue raising aspect of pollution charges seems to dominate. (Kallaste 1994, p. 138-46)

Korea	Air, water	Introduced environmental quality improvement charges (EQIC), notably emission charges, in 1991. The charges were imposed on large facilities (eg. leisure complexes, hotels, department stores), and vehicles (buses and trucks using diesel fuel) which discharge air and water pollutants. The charge on a facility is computed by the cost to treat the estimated amount of pollutants, and that on a vehicle by the price of catalytic converter. In 1993, the revenue from EQIC was about US $45 million (36 billion won), and was used to promote investment in pollution abatement technology and equipment through the Environmental Pollution Control Fund. (Rhee 1994, p. 97)
Lithuania	Air, water	In 1992, a system of pollution charges was developed covering more than 100 air- and 51 water pollutants. Total charges are an increasing function of emissions and rise at an increasing rate (particularly after the source crosses its emission standard). In 1995, the rules of indexation of the charge rates were altered to fully account for the effects of inflation. Total revenue from charges and penalties in 1994 was 21.6 million litas (US $5.4 million), and about 70% of the charge revenue was allocated to municipal government environmental funds. However, the pollution charges are low and unlikely to encourage significant environmental investments. (Semeniene, et al. 1996, p. 4-21)
Malaysia	Water	System of effluent-related licence fees on the BOD load discharged by palm oil mills since 1978. The license mimicked a 2-part tariff, with a variable effluent-related fee and a flat administrative fee: RM 100/tonne for BOD loads exceeding the legal standard and RM 10/tonne for BOD loads equal or less than the standard; plus a non-refundable RM 100 as annual licence-processing fee. Discharge onto land, instead of a watercourse was RM 50/1,000 tonnes regardless of the concentration. Between 1978-81, the total BOD load discharged reduced by 94.2%, despite the rise in the number of mills. However, the risk of shutting down rather than the effluent fee seems to explain the result, since the regulations became mandatory during 1979-81. (Rahim 1994, p. 69)
Poland	Air	Stationary sources of air pollution require emission permits, and the fees are based on type and volume of air pollutants (eg. US$80 per tonne of SO_2 in 1992). This is the principal instrument of air pollution control from stationary sources. Fees apply to emissions not exceeding the standards, and polluters are liable for any damage caused by pollution. The emission charges are an important source of environmental project financing. However, since the charge rates are lower than the marginal cost, they do not provide the right incentives for pollution abatement. (World Bank 1995, p. 67; Bernstein 1993, p. 47; Zylicz 1994, p. 94-95)

Russia	Air, water, land	Pollution charges were introduced formally in Russia in 1991 (in 1988-91 on an experimental basis in the ex-Soviet Union) accompanying the standards. Three types of charges, based on whether: discharges are within the maximum permitted, beyond the maximum permitted but within the temporary permitted, or beyond the temporary permitted. The last two types of charges were to be paid out of the firm profits. The actual charge revenue fell short of the estimate due to the government's inability to collect the charges: in mid-1992 the actual revenue was 2.5-3 billion rubles, while the estimate had been 7 billion. The system was accompanied by non-budgetary environmental fund and taxes on the use of natural resources. (Lvovsky, et al. 1994, p. 16, 22, 26)
Yugoslavia	Water	The effluent charges are based on concentration levels. The system has been ineffective, since the charges are well below the costs of pollution abatement. Also, the charges are not adjusted to the inflation, nor always collected since many public enterprises face severe financial problems. (Bernstein 1993, p. 33)
2. Marketable Permits		
Chile (Santiago)	Air	In 1990, the city allocated bus transit rights and auctioned routes based on fares and types of buses. A tradeable permit system for industry was also introduced on fixed sources, with emissions exceeding 1,000 m^3/hr. Emission tradeoff, however, is not allowed beyond a day, nor across seasons, and property rights are not well defined. (Margulis 1994, p. 116)
3. Deposit refund		
Estonia	Land	Deposit-refund scheme for glass bottles function poorly, probably due to insufficient return outlets. (OECD 1994, p. 136)
Hungary	Land	Glass bottles require deposit fees. (OECD 1994, p. 140)
Korea	Land	Deposit-refund on products that can be recycled (food/beverage containers) or which produce toxic wastes/ voluminous amount of waste (mercury/silver oxide batteries, tires, lubricant oil, electric home appliances). The deposit being low, the refund rate by 1992 was only 8%. (Rhee 1994, p. 99)
Taiwan	Land	In 1989, implemented a recycling system for 12 types of solid waste (including PET/glass bottles, aluminium cans, waste paper, used tires, lubricant oils, mercury batteries etc.). A deposit of NT$ 1/PET bottle increased the recovery rate from 36% in 1989 to 80% by 1992. (Pan 1994, p. 90)

TABLE 2B. INDIRECT INSTRUMENTS (Developing Countries)

4. Input/output tax and differential tax rates

Hungary	Air	In May 1992 a tax of 0.7% of the price was introduced on motor vehicle fuels. The revenue is earmarked (through the Central Environmental Fund) mostly for environmental expenditure relating to vehicle traffic, and the remainder for nature conservation and to raise environmental awareness. The tax rate on lead-free petrol is lower than the leaded variety (market prices inclusive of taxes are almost equal), and consumption tax for new cars with catalytic converters has a discount of Forint 50,000. (OECD 1994, p. 139)
Korea	Land	In 1993, implemented product charges (under its waste disposal charge system) on toxic goods and goods generating large quantities of waste. Items include insecticides, cosmetics, confectionery, batteries (other than mercury and silver), antifreeze solution, fluorescent light tubes, chewing gum, paper diaper, and plastics. (Rhee 1994, p. 104)
Mexico (City)	Air	In 1990 the price difference between leaded and unleaded gasoline was reduced from 40% to 11% (leaded gasoline being cheaper than the unleaded). By June 1994, the excise tax on leaded petrol was higher than that on the unleaded (though the VAT rate was 10% on both). (Margulis 1994, p. 114, OECD 1995, p. 52)
Taiwan	Air	Started promoting unleaded gasoline in 1984. In 1989, the price of unleaded gasoline was cheaper than the leaded by a margin of NT$ 1/litre. Complemented by other regulations on new cars and emissions, the market share of unleaded gasoline increased from 18.7% in 1990 to 51.84% in 1993. The average lead content in ambient air in Taipei decreased from 0.46 g/m in 1989 to 0.18 g/m in 1992. (Pan 1994, p. 91)
Thailand	Air	In 1991, began subsidization of unleaded gasoline to make it slightly cheaper than leaded, in order to reduce atmospheric lead content (1990 USAID study estimated a loss of upto 700,000 IQ points collectively of Bangkok children by age 7, due to elevated blood lead levels). A surtax on leaded gasoline finances the subsidy on unleaded. In Bangkok, unleaded gasoline accounts for 40-50% of the gasoline market. (O'Connor 1994, p. 46)

5. User and administrative charge

Chile	Water	Introduced a system of tariffs for water supply and sewerage collection in 1991, to increase the efficiency in water use, promote equity among consumers, and to self-finance the Sanitary Services. The tariff incorporates the marginal cost of service expansion, seasonality of consumption, adjustment for self-financing, and indexation to other prices. By 1994, nineteen enterprises had their tariffs set by the system, serving about 10 million urban dwellers. (Margulis 1994, p. 117)
Colombia	Water	Sewerage tariffs are set at 60% of the water tariff in Cali, 50% in Cartegena, and 30% in Bogota. (World Bank 1995, p. 68)
Russia (cities)	Air, water, land	In 1988-91, charges were used on an experimental basis at the oblast (regional) and city levels. In 1989-90, Kostroma oblast had an user charge (license) for emissions, effluents, or disposed waters within permissible limits, accompanied by a penalty system. In 1990, 70%of the charge revenue (6.1 million rubles) went to a special fund for environmental protection. (Lovsky, et al. 1994, p. 5-6)

6. Subsidy for abatement inputs

China	Air, water	Eighty per cent of the revenue from effluent fines is placed in banks for borrowing by enterprises making pollution control investments. This forms an important source of earmarked pollution control funding. Also, on an average 70-80% of the water effluent fees are rebated to the firms for environmental protection improvements. (Bernstein 1993, p. 47, 32)
Estonia	Air, water	Tax allowances are offered when the polluter invests in cleaner technology or, end-of-pipe equipment. Subsidization does not have a standard procedure, and tax allowances are designed on an individual basis. (Kallaste 1994, p. 140)
Hungary	Air, water, land	Corporate tax allowance of 40% for investments in emission abatement equipment (for air/ water/ hazardous waste). Equipment for environmental protection is liable for accelerated depreciation in 3 years. Scheme for tax allowance was available for joint ventures (foreign capital) producing equipment for environmental protection (100% for first 5 years, and 60% for next five when investment exceeds 50 million forint with more than 30% of foreign capital). Applications for the scheme were considered until 1992. (OECD 1994, p. 140)

India	Air, water	In 1983 accelerated depreciation for pollution control machinery was introduced. In 1990-91, the Ministry of Finance introduced rebates in custom and excise duty for various pollution control equipment: monitoring instruments, and abatement machinery for air/ water pollution. (Mehta, Mundle & Sankar 1994, p. 13-17; Murty 1996a, p. 21-22) The import concessions, however, were removed as of July 1996.
Indonesia	Water	Ministry of Population and Environment provides concessions on import tax duties for waste water treatment equipment. (James 1996, p. 73)
Korea	Air, water, land	Established environmental fund in 1983, which primarily provides cheap credit for firms investing in control technologies and for operators of private environmental facilities like sewage treatment plants. Investment tax credit is 3% (10% for equipment made in Korea) of the value of the investment which are restricted to facilities increasing productivity, energy-saving, anti-pollution, preventing industrial hazards, etc. (O'Connor 1995, p. 15; World Bank 1995, p. 69)
Lithuania	Air, water	Provision for environmental investment subsidies through rebates of pollution charges when emissions decline by at least 25% from the previous year. An environmental fund is scheduled to be created in 1996, to provide access to subsidized credit for investments having environmental benefits. (Semeniene, et al. 1996, p. 26)
Mexico	Air, water, land	Accelerated depreciation, at the rate of 50%/year, for investment in equipment used to control environmental pollution. Also immediate deduction of 91% on investments in new fixed assets (environmental pollution control) permanently located out of the three most polluted cities (Mexico, Guadalajara, Monterrey). (OECD 1995, p. 92)
Taiwan	Air, water, land	Provides import tax exemption on all pollution control equipment, and tax reductions for specific types of investment. In 1992, the total value of import duty exempt equipment was NT$ 14,245 million (total estimated monetary saving on duty by the industry estimated at NT$ 1,068 million). Almost 40% of the value of import exemption was for air pollution control equipment, and 32% for solid waste treatment equipment. In 1992, the total value of investment eligible for concession was NT$ 7,058 (industry saving estimated at NT$ 1,141). Other provisions include: accelerated depreciation in pollution control equipment, and low interest loans for the installation of abatement equipment in the private sector. (Pan 1994, p. 89; James 1996, p. 71)

Thailand	Air water, land	Since 1983, import duties have been reduced upto 10% for water pollution abatement equipment. Partial grants and low-interest loans are provided to set up treatment facilities. An environmental fund, established in 1991, provides credit to firms investing in abatement technology, and to operate sewage environmental facilities like treatment plants. Semi-government organization, Industrial Finance Corporation, offers concessional financing of pollution abatement equipment purchases and lends appr. $8 million/year through the Environment Portfolio. (Kaosa and Kositrat 1994, p. 179; O'Connor 1995, p. 15; James 1996, p. 74)
Yugoslavia	Air, water	Pollution control equipment are exempt from customs duties. Subsidies are also provided for pollution reducing technology, often in the form of reduced interest rates. However, the policies have not had a significant effect on industrial pollution abatement. (Bernstein 1993, p. 35)

7. Enforcement incentive (non-compliance fee)

Brazil	Air, water	Penalty system for violation of air and water pollution standards since 1981. However, fines on atmospheric emissions are arbitrary (the level of pollution from a firm/truck is generally visually assessed: a lot of/ some/ little smoke, as in Rio de Janeiro, Curitiba, Fortaleza, Belo Horizonte) and related to the frequency of violation rather than intensity or toxicity. Revenues from the penalties are insignificant. Also state-owned firms are exempt from fines on violation of water pollution standards. (Margulis 1994, p. 110)
China	Air, water, land	In 1979, introduced a legal charge on industrial emissions exceeding the norms, based on amount and concentration. In 1981 the system was extended nationwide. The penalty charge is increased by 5% per year, after a grace of 3 years, for firms that do not respect discharge norms. New facilities built after the 1979 law and old firms that fail to operate control equipment, face double the rates for non-compliance. A fine of 0.1% per day is levied for delays of more than 20 days in paying discharge fees. Penalties are also imposed for false effluent and emission reports. The system is administered by local Environmental Protection Bureaus, and the charges vary across provinces. Sources are penalized for only the worst-offending pollutant; and the percent deviation of the discharges from the effluent standards is used in calculating the charge. In 1982-86, the compliance rate of steel industry with discharge standards increased from 33.5% to 60.4%. Between 1987-93, the water levy succeeded in reducing the provincial COD intensities at a median rate of 50%, and total COD discharges at a median rate of 22%. (Wang and Wheeler 1996, p. 1-2) The charges, however, are not pegged to inflation, and often lower than the marginal costs of abatement. The system thus has not uniformly effective: firms often pay the fee in the beginning of the year on the basis of the previous year's emissions, and ignore the system for the rest of the year. Where fines are negotiable, firms that cannot afford the fee do not pay. (Potier 1995; Florig, et al. 1995; Bernstein 1993, p. 47)

Estonia	Air, water	Non-compliance fees for exceeding the mandated limits are set as a multiple of the emission tax. The multiplier (5, 50, or 500) depends on the toxicity of the pollutant. (Kallaste 1994, p. 140)
Hungary	Air, water, land	"Environment protection penalties" are levied for violation of standards for waste water, drainage, air pollution, hazardous waste, noise and vibration. The charges are differentiated according to the toxicity and/or degree of environmental damage inflicted. Data on actual measurement, however, is lacking. (OECD 1994, p. 140)
Korea	Air, water	Introduced a charge system on industrial air and water discharges exceeding the mandated norms (based on concentration rates, location, number of violations etc) in 1983. The fines partly finance the Environment Pollution Prevention Fund, but are not high enough to provide the disincentive to pollute beyond the standards. (Rhee 1994, p. 98; James 1996, p. 73)
Lithuania	Air, water	Penalty system accompanies the standard-cum-charge scheme for air and water pollution, and applies when emissions exceed standards. Preferential rates are given when emissions are below the standards. Misrepresention of emissions carries a ten-fold fine. However, penalties are rarely applied (in 1994, penalty rate is estimated at 4%). (Semeniene 1996, p. 14-26)
Mexico	Water	Fines are set according to the severity of pollution, and are adjusted for inflation. Repeated offences lead to closure. Combined with public pressure, the penalty system has proved to be effective. (Bernstein 1993, p. 35)
Russia (cities)	Air, water	A penalty system was introduced along with the pollution charge system in the oblasts (regions) and cities in 1988-91. Eg. in Nizhniy Novgorod, the fines were set up as a function of emissions exceeding the norms. (Lvovsky, et al. 1994, p. 5-7)

8. Suasive instrument

Bangladesh (district)	Water	Significant local community pressure on two urea fertilizer factories in Narsingdi, Bangladesh probably encouraged cleanup efforts by the firms since 1980 (no formal regulation). The firms share a first-stage treatment lagoon (lack of knowledge of toxic pollutants in the community has prevented the initiation of second stage treatment). (Huq and Wheeler 1993, p. 6)
China	Air, water	In 1990 (following the 1989 amendment of the Environmental Protection Law of 1979, which specifies that government at all levels should be responsible for environmental quality in their jurisdiction) a contract system was started in which officials from mayors to firm managers agree to work towards environmental goals. There are rewards for meeting contract goals (but no penalties for failure to do so), like grants, bonuses, or special status with tax breaks and control of foreign exchange. (Florig 1995, p. 271A)

Indonesia	Water	In 1989, a clean river programme, PROKASIH was introduced between provincial governors and company directors; and targeted the 20 dirtiest rivers. More than 1,000 industrial operations entered into agreement and the majority undertook measures to reduce pollution loadings. Firms with the heaviest pollution loads were asked to draw up pollution abatement plans. In 1990-94 there had been a drop in BOD levels in the rivers, but the levels have increased since. Another programme, PROPER, encourages industry to meet industrial standards on effluent discharge: government publishes environmental ratings of firms based on pollution performance, to generate positive publicity. PROPER has had some positive impact on industry performance. (O'Connor 1995, p. 17; James 1996, p. 73)