The Costs of Environmental Regulation in Asia: Command and Control versus Market-based Instruments

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Abstract. *Environmental regulation has been widely applied in Asia, with many governments introducing command and control (CAC) policies to control the levels of industry emissions. This paper first examines the effectiveness of different environmental regulations in Asia. It then examines the cost effectiveness of CAC regulations compared to market-based instruments (MBIs) by evaluating the cost differences between regulation strategies currently employed and the least-cost solution for air and water pollution regulation in the People's Republic of China, India, Pakistan, and Philippines. The paper concludes that MBIs have a clear cost advantage over CAC regulations and that there are considerable gains to be made from moving to a least-cost solution. Finally, the institutional reforms needed to facilitate the implementation of market-based instruments are discussed.*

Introduction

As the fastest growing region in the world, Asia has witnessed a remarkable increase in the level of economic activity over the last quarter century. Inevitably this has been accompanied by increases in emissions of pollutants, with the industrial, energy, and transportation sectors being responsible for both the largest increases in output as well as environmental pollution. In the early years of development, policymakers paid little attention to the environment. Economic growth was the priority and imposing any restraints on that growth was seen as erroneous. Of course some controls on emissions were introduced, but the

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level of effort that went into environmental regulation remained very low. The same applied to investments in infrastructure, in clean technology, and in the collection and treatment of industrial wastes. The public sector simply did not treat this as a priority category and the incentives on the private sector to undertake such investments remained weak or nonexistent.

As a number of the economies in Asia have increased industrial output by more than tenfold since the late 1960s, the realization that environmental protection is not a luxury but a necessity has become clear to policymakers. Health concerns about emissions in air, water, and soil have increased substantially in recent years. As a result, governments have introduced a number of measures to control pollution and to treat such wastes. The underlying philosophy behind the measures has been a "command and control" (CAC) one: polluters are required to adopt certain cleaner technologies, or to meet specified standards for emissions. But, as this paper shows, these measures have been much less successful than was hoped. Weak enforcement (few inspectors, small fines, and corruptible officials) as well as widespread exemptions are responsible for this state of affairs. Furthermore, the "polluter pays" principle, under which the party responsible for generating the pollution should pay for any measures to reduce or eliminate it, has not been generally observed. In many instances polluters asked for and received subsidies to install cleaner technologies and to control and treat wastes. In following these policies, it is important to note that the Asian countries are only doing what has been the standard practice in many countries of the Organisation for Economic Co-operation and Development (OECD). The latter were more successful in their strategy for a number of reasons, the foremost of which are better enforcement and monitoring. But the OECD countries are increasingly realizing that CAC measures are not sufficient and a shift to "market-based instruments" (MBIs) is notable in almost all countries.

These MBIs are measures that use fiscal incentives to obtain the desired reduction in emissions, rather than impose rigid technological and physical constraints on the polluters. The main reason for this shift in the advanced economies has been the realization that CAC solutions have been very costly in terms of resources. Making all polluters face the same regulations allows for little flexibility in meeting a target level of environmental quality. In the United States and elsewhere this became apparent as the environmental standards that had to be met have risen, and as the cost of meeting those standards, in terms of less industrial activity and more unemployment has become more evident.

Initially the prevalent view was that market-based instruments were too sophisticated to be used in less developed economies. After all, it was argued, they had not proved themselves in developed economies, so how could they be expected to work in circumstances where markets were less well developed? While there is some truth in the view that MBIs for environmental regulation are evolving everywhere rather than being applied from an established blueprint, there is no justification in the view that this evolution should not take place in developing countries at the same time it does in industrialized countries. In some respects the imperative for using such instruments is even greater in the former. These countries can ill afford the higher costs of CAC strategies, and they have even less capacity for the larger enforcement infrastructure that CAC policies require. As this paper shows, many Asian societies are simply not accustomed to using litigation and court procedures to enforce pollution standards. Indeed there are some initial attempts to use and develop MBIs for environmental regulation in Asia (see Markandya 1997 for details).

The paper is organized as follows. The second section looks at the scope for cost savings and environmental improvements that can be attained through a policy of reducing subsidies to economic activities that cause environmental degradation. Overall estimates of the amounts of these subsidies and of the environmental damages they cause provide some strong evidence of the scope for both environmental improvement and cost savings by this route. It is also important, however, to insert a note of caution. There are cases where subsidies are environmentally beneficial and, in order to make a full assessment of the impacts of such subsidies, it is necessary to look at economywide impacts, not just at the impacts in the sector receiving them.

The third section focuses on specific cases of regulation of air and water pollution. It examines the costs of meeting certain air pollution controls for various pollutants (sulfur dioxide [SO_2], particulate matter [PM], nitrogen oxide [NO_x], carbon monoxide [CO], and hydrocarbons [HC]). It also reviews the costs of policies in the water sector to reduce water effluents in the form of chemical oxygen demand (COD), biological oxygen demand (BOD), and total suspended solids (TSS). The studies draw on data from People's Republic of China (PRC), India, Pakistan, and Philippines. With more data this kind of analysis can be extended to other countries, but the basic message is clear from the studies quoted—in most cases, major savings are possible by moving to a more market-based approach in environmental regulation.

Finally, the fourth section discusses the institutional reforms required to make this shift and concludes the paper.

Potential for Reducing Environmental Damage through Reduction in Subsidies

What Constitutes "Market-based Policies"?

The pursuit of market-based policies is driven by the need for cost efficiency; they allow environmental quality standards to be met at a lower cost than policies based on direct regulation. The issue, of course, is an empirical one. How much do market-based policies save in economic costs compared to CAC policies? In this section the empirical magnitude of these savings is estimated and analyzed.

In looking at market-based policies for environmental regulation it is important to cast the net widely. Conventionally, one includes emissions charges, tradable permits, and other incentives that encourage enterprises with relatively low abatement costs to undertake pollution reduction measures. While it is certainly important to look at such instruments, it is equally important to look at other market-based reforms that can yield improvements in economic performance as well as environmental amelioration. Prominent among so-called "win-win" policies is the removal of subsidies to economic activities that are environmentally harmful. Going beyond subsidies, there are also possibilities of increasing the taxation of environmentally harmful emissions arising from the use of fossil fuels. The taxes collected provide much needed revenue for environmental investments at the same time directly improve the environment.[1]

This paper does not provide a review of the empirical scope for all such "win-win" policies. In particular, it does not cover the taxation of fossil fuels and other environmentally harmful taxes. The issues involved in making an evaluation of the economic gains and losses are complex and require the use of intersectoral models of the economy. The construction of such models, along the lines of Capros et al. (1996) is certainly desirable but beyond the scope of this paper.[2]

Cost Savings from Policy Reforms

As Markandya (1994), Panayotou (1996), and others have pointed out, removing or phasing out costly subsidies that distort the economy and cause environmental damage is one of the most cost-effective means for achieving the twin goals of environmental protection and economic development. Areas where such subsidies are significant include the consumption of fossil fuels, electricity, water, pesticides, logging, land clearing, and construction.

Panayotou (1996) reports estimates of subsidies worldwide as follows: energy (US$300-400 billion); agriculture ($350-380 billion); transport ($100-200 billion); water ($10-20 billion), and extractive industries (up to $240 billion). These amount to around $1 trillion worldwide, or about 5 percent of the world's GNP. He also estimates that removing one dollar of subsidies generates 24 cents of reduction in environmental damages. Hence the overall benefit of removing all subsidies is

[1]They also allow for the possibility of reducing other taxes that are distortionary and economically harmful. See Goulder (1994) for a discussion of this issue and Welsch (1996) for some empirical estimates for Europe.

[2]In fact a proper analysis of subsidies should also make use of such more sophisticated models. One such model that looks at subsidies in a wider context is Panayotou and Sussangkarn (1991). This is discussed later in this paper.

estimated at $240 billion. Figures for all the Asian Development Bank developing member countries are not available but it is worth noting that such subsidies are not especially to be found in any one set of countries. Indeed OECD countries have some of the largest subsidies. Hence the assumption that, in broad terms they are proportional to GNP may not be too inaccurate. On that basis, the low and middle-income countries of Asia, which account for 7.5 percent of the world's GNP, would account for $75 billion of the subsidies. This in turn, if removed, would produce $18 billion of overall economic benefits. The benefits will take the form of reduced environmental damage, which has a real economic value, as well as the more efficient use of natural and other scarce national resources. In addition, the reductions in subsidies have a macroeconomic benefit, in that they reduce the fiscal deficits and make the process of structural adjustment easier. This can be very significant.

Although the above figures are very crude and can only be regarded as orders of magnitude, they indicate the extent of savings in economic costs that are available if the subsidies are removed. At the same time, it is important to be aware of the political difficulties of making these changes in subsidies; probably the most difficult policy for any government to implement is the removal of a subsidy, the benefits of which accrue to a group of well-organized individuals. This applies to developed as well as developing countries.

The figures of the benefits of subsidy removal provide a macro picture of the subsidy story. Some Asian countries have undertaken the removal of specific subsidies, which can provide some useful examples of what can be achieved in practice. A number of these are detailed below.

Pesticides in Indonesia

The following case is taken from Panayotou (1993). During the late 1970s and 1980s, a green revolution took place in Indonesia. Pesticide use was encouraged by subsidies, which by 1985 had increased to 82 percent of retail price at a total cost of $128 million. From 1976 to 1985 pesticide use increased by 76 percent with devastating environmental consequences. Widespread use of the pesticide Sevin wiped out the natural predators of the rice pest brown planthopper, resulting in drastic losses of rice (e.g., in 1976, some 364,500 tons were lost, valued at $100 million). By 1985, 70 percent of Java's rice crop was threatened, and economic studies showed negative returns to heavy insecticide use.

In November 1986 the following measures for regulation were announced.

(i) 57 pesticides were banned (20 of these had been heavily subsidized).

(ii) Subsidies to remaining pesticides were decreased and gradually eliminated.

(iii) Integrated Pest Management (IPM) was introduced, including only limited use of pesticides priced to reflect true cost.

To implement this strategy the government cut subsidies from 55 to 40 percent of retail values in October 1988, and in December 1988 eliminated subsidies altogether. To lessen the impact on poorer farmers the floor prices of unhusked rice, yellow corn, soybean, and mungbean were increased. A program of research into appropriate pest control technologies was introduced and information disseminated to farmers.

Three planting seasons after the strategy was adopted, the FAO reported a 90 percent reduction in pesticide use, and average yields rising from 6.1 to 7.4 tons per hectare. Since the introduction of IPM, Indonesia has had record levels of rice production, and use of pesticides has declined from 4.1 to 1.7 applications per season. Savings in government subsidies are $120 million (year not given). A cost-benefit analysis showed the economic rate of return of the IPM program to be 47.5 percent. The overall impact is the product of several factors, most important of which was the implementation of the IPM program. But the incentive to adopt this program was significantly provided by the removal of pesticide subsidies.

Pesticides in Pakistan

One of the first countries to phase out pesticide subsidies was Pakistan in 1980. In an ADB (1993) study, total supply fell from 4,067 tons in 1979 to 1,525 tons in 1983. The total subsidy fell by 30 percent to Rp1.7 billion ($132 million) in 1983-1984. The volume of pesticides in terms of active ingredients has also fallen, and various inefficient practices like aerial spraying have ceased. Overuse and misapplication have also fallen as prices have risen.

Water Pricing in People's Republic of China

There are many cases of subsidized or free irrigation water that cause farmers to use the resource beyond the economic optimum, for example in India, Pakistan, and Thailand. Overirrigation by farmers nearest to the water source can lead to water logging, salinization, and alkalization, while those further away have to rely on a sporadic and sparse supply.

In the case of the People's Republic of China (ADB 1991), the government instituted agricultural policy reforms in July 1985 that gave a greater degree of financial and managerial autonomy to provincial agencies and promoted greater efficiency in irrigation water usage by pricing more closely to actual water costs. Irrigation service fees are set to cover operation, maintenance, and amortization of capital costs. In 1980, a switch from financing systems with loans rather than grants encouraged water management agencies to collect higher water fees, with greater flexibility in pricing according to season and area.

As a result of these policies farmers have begun to irrigate crops more efficiently, and water use per hectare has declined. Decentralized management has contributed to greater efficiency by distributing according to land area, charging on volumetric rather than flat rate basis, and preparing distribution plans. Crop production is said to have become twice that of similarly irrigated crops in India but no figures are given. These changes in relative yields are undoubtedly due to many factors, among which one could be the better pricing of water.

Chemical Fertilizers

This example is reported in Panayotou and Hupe (1995). Many Asian countries heavily subsidize chemical fertilizers. In 1984, the Philippines sold urea at 30 percent below cost, and Sri Lanka at 56 percent below cost. In India, 30 urea-producing plants would not survive without subsidies. The cost of subsidies in 1983/1984 was over Rp9 billion ($792 million) and by 1989/1990 this had risen to Rp45 billion ($2.57 billion). Subsidies in India have now declined, with the price of urea increasing by 30 percent in July 1991. Also, in August 1992 the government lifted price controls on potassic and phosphatic fertilizer, resulting in price rises of over 100 percent. Political pressure led to a subsequent reduction in the price of urea by 10 percent. The environmental effects of these changes have not been analyzed. There will be a number of positive impacts, but there could also be some negative impacts if output declines and farmers increase land area under cultivation to make up for a drop in yields. Casual evidence suggests, however, that output has not declined in this way.

Oil Prices in Thailand

This example is based on a study by Panayotou and Sussangkarn (1991). In the 1980s liquefied petroleum gas (LPG) and kerosene were subsidized in Thailand at a rate of 6 to 13 percent. An oil fund operated to allow cross subsidization among petroleum products, which had the unintended effect of encouraging conversion of automobile engines from gasoline to LPG. This distortion has been reduced (but not eliminated) since 1989 through a series of price adjustments. This is one case, however, where the subsidy may have had some environmentally beneficial effects. As TDRI (1990) states, the use of LPG is environmentally beneficial compared to gasoline because of its low-carbon, low-sulfur characteristics. As the subsidy is lifted, the emissions can be expected to increase.

In a more general context, in order to study the impacts of the removal of a subsidy on oil and gas prices in Thailand, Panayotou and Sussangkarn (1991) examined the effect of a 10 percent increase in oil and gas prices in Thailand in an economywide modeling context. The main environmental impact is the reduction in energy-related emissions due to more efficient energy use and conservation. The transport and industrial sectors turn out to be the most affected with a 0.90 and 0.41 percent reduction in activity respectively, suggesting a greater reduction in HC, VOC, NO_x, and CO than SO_2 and SPM. Looking at the broader economic impacts of the price changes, the model suggests this price rise will tend to reduce poverty in relative terms and increase it in absolute terms and therefore "the impact on the environment is ambiguous until we are able to estimate and compare elasticities of resource depletion and environmental degradation with respect to absolute and relative poverty" (Panayotou and Sussangkarn 1991, 80).

Conclusions on Policy Reforms

This section has demonstrated the considerable scope for achieving environmental and economic gains from the removal of environmentally harmful subsidies. The picture, is not, however, all one-sided. In some cases the impacts of the subsidy removal are ambiguous. There are also situations in which a subsidy can have environmentally beneficial impacts, and the overall analysis of subsidies requires the use of economywide models. Households and firms may respond to a financial squeeze caused by a subsidy removal by increasing environmental damages elsewhere. It is difficult to analyze such impacts without the proper modeling tools, which are not generally available. It is encouraging, however, that these are now being developed.

Cost Differences between Present, Least Cost, and Market-based Policies

What Advantages do Market-based Policies Bring?

The main reason why market-based polices do better than CAC ones is their cost effectiveness. They achieve a given reduction in emissions, or a given improvement in environmental quality, at a lower cost than do CAC measures. To illustrate, suppose that there are two types of polluters, A and B, each emitting one million tons of pollution a year. The cost of reducing one ton for polluter A is $100 while that for polluter B is $200. If both are asked to make a reduction of half a million tons, the total cost will be $150 million. If, however, the least cost option is selected, the cost of the same reduction will be only $100 million (all reductions are made by polluter A).

In this example, both market-based and CAC instruments could produce this solution. The CAC policy would simply require polluter A to adopt the clean technology. The market-based instrument could do it in a number of ways, one of which would be a tax of just over $100 per ton. Then polluter B will find it preferable to pay the tax and polluter A to make the reduction.[3]

Although in the simple example both instruments get to the least cost solution, in more realistic cases the MBI is more cost-effective. First the regulator does not have access to all the information on abatement costs and typically uses a technology-based standard. This cannot take full account of the differences in abatement costs between industries and between firms in an industry. Second, MBIs provide a dynamic incentive for improvements in technology that CAC measures do not. The fiscal incentive means that a firm will always benefit from reductions in emissions, whereas it will not benefit as much if it is in compliance with a technology standard.

The above argument for MBIs does not take into account one important factor—the spatial dimension. Suppose that polluter B's emissions are causing more damage per ton emitted than polluter A's. Then it may be appropriate for the regulator to control B rather than A. The CAC instrument could do that whereas the MBI would need to set the charge at $200/ton, a level that would elicit a higher overall reduction than was being sought. This is an important point and means that the case for MBIs over CAC instruments is not as clear-cut as might appear at first sight. Two observations are in order here. First that there are many pollutants for which the spatial dimension is not as important as might first appear. Consider, for example, particle pollution, where emissions of sulphur and PM_{10} (particulate matter with a diameter of less than 10 microns) have a local effect. As aerosols, however, they also have long distance impacts, which dominate the total damages (see ExternE 1995). It is possible for the MBI to address the "non-spatially sensitive" component of the pollution and leave the CAC component to take account of the local variations. Indeed this is what is done in the US, for example, where local "hot spots" have further restrictions on them and the MBI is focused on the regional or national aspect of the problem.[4] In this paper, the spatial aspect is not addressed. Instead the focus is on the cost savings in using MBIs to address the second dimension. The comparison between CACs and MBIs is based on actual national targets or on possible national targets that are very common in environmental policy. Where, however, there is a local dimension that the CAC instrument is addressing, this has been mentioned.

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[3] The tax revenues would have to be recycled if they were not to have other impacts, but that can be done and raises separate questions of distribution.

[4] For this more complex case, Tietenberg (1992) has shown that the MBIs still have a significant role to play in reducing overall costs of compliance (see also Markandya 1996).

In this section, the potential benefits of cost reduction using market-based instruments are explored for industrial air and water pollution. The basic model estimates the least cost solution and compares it with various CAC solutions that have either actually been proposed or could be considered as "typical".[5]

Air Pollution Regulation

In this section air pollution regulation costs are analyzed for PRC, India, Pakistan, and Philippines. The first two (PRC and India) are analyzed using data on target reductions in SO_2 and PM, as set out in ADB (1992). This study also estimates the costs associated with the reductions, based largely on tackling the power generating sector. Given the range of abatement costs for different sectors, a "least cost" estimate of achieving the same goals has been made and compared with the estimates of the ADB study. In fact, the costs obtained here are not the "full least cost", for reasons that are given below. Hence the savings in going from the Bank regulated solution to the true least cost solution will be even greater than those shown in this paper. The final part of the analysis discusses how the least cost solution can be attained as a market-based solution and what problems one can expect to encounter in the process.

The second part of this section looks at data from the Philippines and Pakistan. For the Philippines estimates of the costs of a 90 percent reduction in PM_{10} has been made by Rufo and Delos Angeles (1996). The same paper also provides some information on the costs of reductions in the different sectors. Using this data, a comparison of the least cost solution with a solution in which every sector makes a 90 percent reduction is made. Again, as with the analysis of PRC and India, reasons why the true least cost would be less than estimated here are given, and the market-based instruments that would allow the true least cost solution to be approximated are provided. For Pakistan, data on the emissions by sector are given but the costs of abatement are not. Using estimates on costs of abatement by sector as estimated by the World Bank, the costs of attaining given target reductions in SO_2, NO_x, CO, and HC are made. The same analysis of the accuracy of the "least cost solution" and of how it can be attained through MBIs is provided.

[5]It could be argued that some of the CAC alternatives are too simplistic and that in practice regulators would be more selective in the industries they would target for the reductions. While this may be true, it is also the case that the benefits of market-based instruments are underestimated. Later sections of the paper explain why this is the case. The overall impact of both "biases" is unclear but in the author's opinion, the cost-effectiveness of market-based instruments remains unchallenged.

Air Pollution Regulation Costs in PRC and India

In ADB (1995), Wearley reports on the investments that will be required in the power sector over the period 1992 to 2000 in several developing member countries to achieve certain percentage target reductions in emissions of major pollutants from the power sector. An earlier study (ADB 1992) gave the estimated emissions under a business-as-usual scenario for SO_2 and PM from 1988 to 2000 for PRC and India, and Indonesia. This allows one to calculate the reductions in emissions that will be achieved as part of the investment package.

In order to calculate the least cost of achieving these reductions, costs of abatement per ton of SO_2 and PM were taken from Hartman, Wheeler, and Singh (1994) and ERM (1996). Hartman et al. carried out a study of abatement costs in US manufacturing outfits at the 4 digit industry level and reported figures for 37 industries. Their figures were grouped into costs for: food, beverage, and tobacco; textiles and clothing; machinery and transport; chemicals; and "other". Emissions within each of these categories were estimated from the shares of manufacturing that each group represented and the share of the use of coal in each sector (power and industry). The shares of use of coal by industry and power are approximate and need to be confirmed. For electricity, ERM reported the most recent costs of removal of SO_2 and PM from the electricity sector. The cost ranges for all sectors are given in Table 1 below, which include the annualized capital cost (using a discount rate of 10 percent) and all variable costs. Given the wide range of costs, it is assumed that the distribution of these costs within each category is uniform. This is clearly an approximation, but at this stage the data for a more detailed analysis were not available.

Table 1: **Costs of Abatement for SO_2 and PM**
($/metric ton)

Industry	Costs for SO_2	Costs for PM
Power	375-816	216-3000
Food, Beverage, and Tobacco	167-521	86-268
Textiles and Clothing	67-535	272-445
Machinery and Transport	245-1563	125-635
Chemicals	75-1045	46-269
Other	26-3043	38-1208

Sources: Hartman, Wheeler, and Singh (1994); ERM (1996).

The model works by essentially estimating the cost of abatement curve across all industries, and then undertaking abatement in accordance with that curve. If a certain reduction is to be achieved, it starts by selecting the lowest cost abatement option and working sequentially upward selecting progressively higher cost options, until the target reduction is met. The model has to be dynamic because new industries are being set up to meet a growing demand. Hence in each period the set of cost options changes as new plants with new costs of abatement are brought in.[6] The model thus gives the least total cost of meeting a given reduction target as selected in ADB (1995), as well as the marginal cost of abatement in each period.

The results are summarized in Table 2. Details for this set of calculations can be found in Markandya (1997). The ADB costs had to be converted into annualized costs; in doing this it was assumed that the pollution investment equipment had a life of 25 years and that a discount rate of 10 percent applied. To these capital costs were added the variable costs, which were taken as 40 percent of total costs or 67 percent of the capital costs. These are typical for abatement programs for coal reduction, but more accurate figures should be used for the other sectors.

The table shows that the least cost solution to the reductions in emissions is 10 percent of the proposed costs for the PRC and 31 percent for India.[7] It may be argued that the projected costs in the ADB report include reductions of other emissions other than SO_2 and PM, particularly NO_x. While there may have been some reductions in other pollutants, the extent to which they will entail additional costs to those incurred with respect to reducing SO_2 and PM are likely to be small. The main reason for the gap between the least cost and the proposed cost is that reductions outside the power sector can play a much more effective role in achieving the targets. For both PRC and India, power sector reductions in SO_2 are not sought until 1998 but industrial emissions reductions begin in 1993. Marginal abatement costs work out at $50-130 per ton of PM and $80-207 per ton of SO_2 for the PRC. The figures generally rise over time (unless the reduction targets can be met solely from investment in clean technology in new plants). For India the ranges are $60-100 per ton (PM) and $100-300 per ton ($SO_2$).

[6]No retirement of capital is allowed for in this model. One would expect older stock to be retired over time thus lowering the cost of phasing out polluting industries. However, the period of the calculation is short and the error in making this assumption is probably small. Given the lack of data on the age profile of the capital it was essential to make this assumption.

[7]The Indian estimate of PM emissions is taken as 4.3 million tons in 1988. ADB (1992) gives the figure as 43 million tons, which must be a mistake (it is over three times the PRC emissions). It is assumed that there is an error in the decimal place in the report.

Table 2: **Cost Differences Between Proposed Program and Least Cost Solution to Reduce Pollutants for India and PRC**

	PV	1992	1993	1994	1995	1996	1997	1998	1999	2000
India										
ADB Investment Cost ($ million)		342.00	532.00	735.00	950.00	1178.00	1451.00	1741.00	2083.00	2464.00
ADB Annualized Investment Cost ($ million)		37.68	58.61	80.97	104.66	129.78	159.85	191.80	229.48	271.45
Variable Cost ($ million)		25.24	39.27	54.25	70.12	86.95	107.10	128.51	153.75	181.87
Total Annual Cost of ADB Program ($ million)	1179.73	62.92	97.88	135.23	174.78	216.73	266.96	320.31	383.23	453.33
Least Cost of PM Removal ($ million)	193.73	1.56	4.70	10.28	19.12	29.20	45.24	66.23	89.04	114.25
PM Marginal Cost ($/ton)		60.15	82	99.2	115.98	129.25	144.3	160.24	66.37	109.7
SO_2 Least Cost ($ million)	172.68	1.25	3.82	8.46	16.07	25.92	40.01	59.25	79.85	105.44
SO_2 Marginal Cost ($/ton)		103.00	146.00	185.30	220.50	256.50	288.50	264.50	290.60	332.00
Total Least Cost ($ million)	366.41	2.81	8.52	18.74	35.19	55.12	85.25	125.48	168.89	219.69
Difference: Least Cost versus ADB (%)	31.1									
PRC										
ADB Investment Cost ($ million)		1215	1938	2742	3635	4627	5846	7199	8837	10719
ADB Annualized Investment Cost ($ million)		133.85	213.51	302.08	400.46	509.75	644.04	793.10	973.56	1180.89
Variable Cost ($ million)		89.68	143.05	202.39	268.31	341.53	431.51	531.38	652.28	791.20
Total Annual Cost of ADB Program ($ million)	4743.87	223.54	356.55	504.48	668.77	851.28	1075.55	1324.48	1625.84	1972.09
Least Cost of PM Removal ($ million)	193.76	2.08	5.99	11.69	20.60	29.93	42.95	68.52	86.25	108.09
PM Marginal Cost ($/ton)		51.80	66.60	82.70	92.50	99.80	108.90	118.10	127.50	135.90
SO_2 Least Cost ($ million)	300.69	3.41	9.67	18.45	31.76	47.87	69.77	100.83	132.69	168.10
SO_2 Marginal Cost ($/ton)		80.00	96.80	115.30	136.00	158.30	175.60	184.00	195.10	209.50
Total Least Cost ($ million)	494.45	5.49	15.66	30.14	52.36	77.80	112.72	169.35	218.94	276.19
Difference: Least Cost versus ADB (%)	10.4									

Notes: Pollutants referred to are PM and SO_2
Variable costs are assumed to be 40% of total costs.
Sources: ADB (1992), ADB (1995), author's calculations.

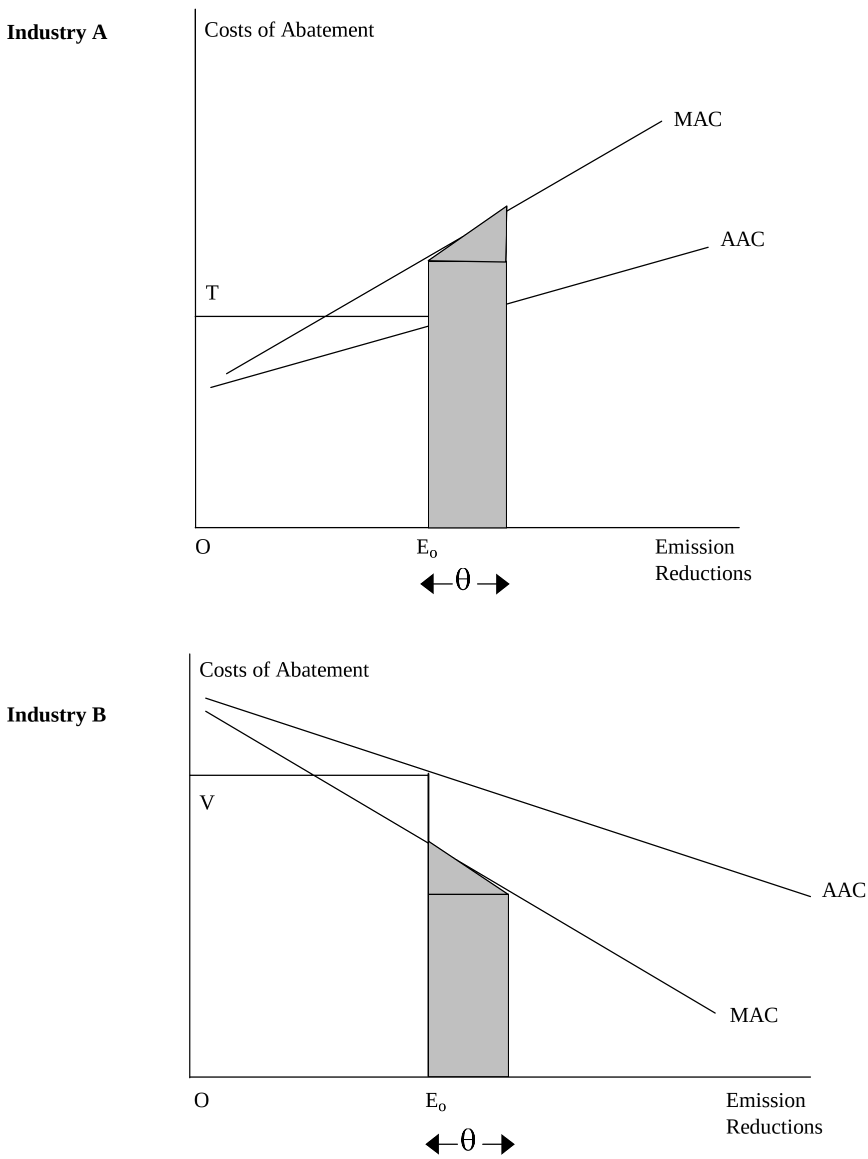
The fact that India has a ratio of proposed cost to least cost of about 3, whereas the PRC has 10 can be explained by differences in the proposed investments in the two countries. The programs can, to a lesser or greater extent, mimic the least cost solution. If the planners select their investments judiciously they can reduce the costs; if they are less selective the costs will be higher. It is virtually impossible, however, for planners to achieve the least cost solution by a CAC policy, because they will never have the necessary information on the abatement costs for thousands of individual plants that need to be controlled. The range of CAC to least cost solutions has been studied in OECD countries. Tietenberg (1992) reports on a number of such studies, which show a range of values for this ratio of between 1.8 and 22 for different air pollutants.

How Accurate is the "Least Cost" Solution

The "least cost" solution presented above is not in fact a true least cost. There are two important factors that have been left out of the analysis. The first is that the estimates given are based on average abatement costs for the regions of abatement that Hartmann et al. observed per enterprise in the US, and not on average abatement costs as function of levels abated. Data on the latter would allow a more cost-effective allocation of reductions to be made. This can be seen in Figure 1. There are two industries, A and B. In industry A the estimated average abatement cost is higher than in B, but in A it is falling with mean tons abated whereas in B it is rising. Initial emissions reductions in both industries are E_0. A further reduction of θ is required. The average abatement cost in industry A is OT, which is less than the same cost in industry B (OV). Hence industry A is chosen for the reduction. But the actual costs of the additional reduction of θ in each industry are shown by the respective shaded areas. Clearly they are less in B than in A. The problem is that, in order to carry out this calculation, it is necessary to have data, not only on average abatement costs as function of tons abated, but also on the distribution of firms in each sector and level of emissions by firm. This was not available.

The second problem is that the cost estimates are reported averages for each industry. Some firms will have higher costs and others will have lower costs. If one could select the least-cost firms, as shown in Figure 2, the overall costs of making the reduction would be less. Again, since these data are not available, it is not possible to estimate the savings from a more targeted least cost solution. It is important to note, however, that an MBI, such as a charge, automatically selects the least-cost firms for the reduction, as those are the ones that find it profitable to undertake the abatement.

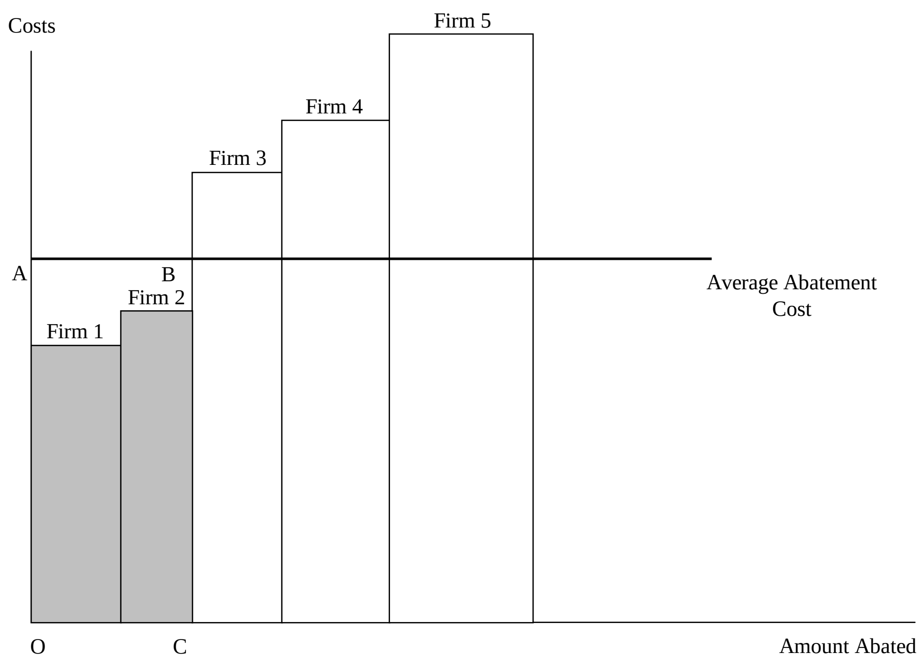
Figure 1: **Abatement Costs Vary with the Level of Abatement**



MAC: Marginal Abatement Cost
AAC: Average Abatement Cost

Initial emission reductions in both industries are E_0. A further reduction of θ is required. The average abatement cost in industry A is OT, which is less than the same cost in industry B (OV). Hence industry A is chosen for the reduction. But the actual costs of the additional reduction of θ in each industry are shown by the respective shaded areas. Clearly they are less in B than in A.

Figure 2: **Actual Costs of Abatement are Lower than Average Costs**



The figure gives the average costs of abatement for different firms. The average across all firms is given by the bold line and is OA. The estimated cost of achieving a reduction of OC is the area OABC. But the true cost of that reduction is the shaded area, which is less.

Market-Based Solutions

The next question is how can policymakers get closer to the least cost solution? The most promising approach is to use some kind of market-based instrument. Broadly speaking, the choice is between an emissions charge on SO_2 and PM, or a system of tradable permits for each of these pollutants. The arguments for and against each of these instruments are well known and will only briefly be referred to here. With a charge there is a burden on all polluters and the impact in terms of emissions is uncertain. Moreover, the level of the charge has to be adjusted to keep its real value constant in the presence of inflation. With a permit system, the impact in terms of emissions is certain but the cost implications for enterprises are less well known. The burdens on industries can be limited by issuing the permits in some relation to existing emissions (known as grandfathering). Concerns have been expressed about the impacts of tradable permits on market power (a few polluters could acquire all permits and thereby limit competition). By and large this last issue has been found not to be a serious problem (Tietenberg 1992).[8] Outside of Asia, emissions charges have been introduced in a number of European countries (including economies in transition), and permit schemes have been initiated in the USA.

Both these MBIs could be implemented in the industrializing Asian economies and, as has been noted in the first section, some applications of charges already exist. Cost efficiency would, in principle, be achieved by both instruments. If a tax equal to the marginal costs reported in Table 2 were imposed on all emissions of SO_2 and PM in each country, enterprises that sought to minimize costs would adjust their level of emissions to equate the charge to the marginal abatement costs, thereby achieving the least cost solution. Likewise, with tradable permits, emitters would acquire permits to the extent that the costs of abatement exceeded the price of the permit, and would adjust the level of emissions so that the price was equal to the marginal cost of abatement. The major differences between the two arise with respect to the uncertainties about the costs of abatement and as to the impacts that they have on the profitability of enterprises, and through that on employment and output in the affected industries.

Although both instruments predict a least cost solution, in practice such a solution is never achieved. First, not all enterprises are cost minimizers, which means that they will not respond as suggested above. Second, there will be some underreporting of emissions if a charge is levied (Panayotou 1995 cites underreporting by as much as 75 percent in the PRC). On the positive side, a charge system will encourage the lowest cost enterprises to undertake abatement, so that the actual costs incurred will be similar to the shaded area in Figure 2, instead of being equal to the average costs shown in that figure. For all these reasons, the actual outcome will differ from the predicted least cost outcome. As has been noted earlier, there is very little experience in industrialized countries of actual MBIs, and comparisons between their achievements and the least cost solutions are very few. Most studies report simulations of the benefits of MBIs over CACs, assuming that the former will achieve the least cost solution, or something close to it (Tietenberg 1990, Hahn and Hester 1989). In practice, the experience referred to in the second section suggests that, to achieve success with a charge system in this context the following points should be addressed:

[8]A reviewer has also pointed out that grandfathering could result in strategic behavior, where firms increase their emissions prior to the regulation to get more permits. This can be avoided by making the allocation on the basis of historic emissions (prior to the policy announcement). The policy can also cause difficulties for new firms. Regulators avoid this by keeping some of the permits for allocation by auction. The Singapore scheme for CFCs tradable permits is such a mixed case.

(i) The charge should be set in a way that allows for inflation adjustment. Any increases in charges that are planned should be announced well in advance.

(ii) In order to reduce the costs of compliance to existing industries, charges may be phased in over a period of time.

(iii) Facilities for the measurement of emissions and monitoring by the regulatory authority should be in place before the charge is introduced and the costs of measurement should be taken into account when defining the coverage of the charge. In this context, it may be necessary to exclude some polluters from the charge system, if the costs of monitoring exceed the efficiency gains. Instead, they may be regulated through charges on inputs and/or outputs that are closely correlated with the emissions.

(iv) Subject to (iii) above, exemptions should be kept to a minimum.

If a permit system is introduced, experience has shown that the following points should be observed:

(i) Issuance of permits has to be based at least in part on existing emissions (i.e., permits have to be grandfathered). Some may be allocated by auction.

(ii) Permits acquired now and not used can be "banked"—i.e., the purchaser can use them at a later point in time.

(iii) In both cases the MBI should replace existing regulations as much as possible. Some additional controls will, however, be required to deal with local pollution problems (so-called hot spots).

Air Pollution Regulation Costs in the Philippines and Pakistan

In the Philippines, a major study (The Environmental and Natural Resources Accounting Project, or ENRAP) collected a lot of information on the costs of pollution regulation by industry, along with emissions data (Rufo and Delos Angeles 1996). For air pollution, data for 34 industries were provided for 1992, along with the annual cost per ton of PM_{10} removed. These costs were based on actual Philippine data and are therefore preferable to the World Bank estimates used in the calculations of the PRC and India abatement costs. The ENRAP project calculated the total cost of a 90 percent reduction in emissions from each of the sectors. These came to ₱16.7 billion or about $668 million.

Exploiting the differences in average abatement costs between industries, one can achieve the same overall reduction at a cost of ₱11.9 billion ($476 million), which is about 30 percent lower. The calculations showed that a charge per ton of ₱16,600 per ton ($664) will be required to attain the least cost solution. In practice there are considerable variations in unit abatement costs within the industrial sectors, which the enterprises will be able to exploit when a charge scheme is imposed. For this important reason, a charge scheme could have lower costs of attainment for the target reductions. Table 3 summarizes the results for a 90 percent and a 70 percent reduction in overall emissions.

Table 3: **Costs of PM_{10} Reduction in the Philippines**

	90% Reduction	**70% Reduction**
Total Reduction (million tons)	1.95	1.52
Total Cost with Uniform Reduction ($ million)	669	476
Total Cost with Least Cost Strategy ($ million)	520	334
Marginal Cost of Abatement ($/ton)	16.6	5.8

Note: An exchange rate of 25 pesos to the US dollar is used (1992 exchange rate).
Source: Rufo and Delos Angeles (1996).

In the case of Pakistan, a similar analysis was carried out, except that data on abatement costs were not available. Hence average abatement costs from the World Bank study are used. The number of sectors is half of those in the Philippines (17 as opposed to 34). On the other hand, emissions data are available for more pollutants (SO_2, NO_x, CO, and HC). The resulting estimates of a uniform reduction against a least cost reduction are given in Table 4 below.

The cost savings for Pakistan appear to be small for SO_2 largely because most of the emissions come from one sector (bricks). In such a case the analysis has to look at the cost differences between brick plants, and this was not possible without enterprise level data. To a lesser extent the same problem applies to NO_x/CO (where figures are dominated by bricks and sugar refining), and HC (where sugar refining accounts for 75 percent of the emissions).

For these reasons the estimated difference between the uniform reduction cost and the least cost solution in both the Philippines and Pakistan will be underestimated. On the other hand, it is unlikely that a government, given the information on abatement costs by industry, will opt for a CAC policy that requires a uniform reduction strategy. It would be sensible to target the least-cost industries for the major reductions. By doing this, the costs of the CAC can be lowered. It is impossible to say how the comparison will change once allowance has been made for both factors (the overestimation of the least cost solution and of the CAC solution). From previous studies, however, one can remain confident that the least cost solution will remain dominant by a considerable margin.

Table 4: **Costs of SO_2, NO_x/CO, and HC Reduction in Pakistan**

Reduction	**70% Reduction**
SO_2	
Total Reduction ('000 tons)	315
Total Cost with Uniform Reduction ($ million)	71
Total Cost with Least Cost Strategy ($ million)	66
Marginal Cost of Abatement ($/ton)	213
NO_x/CO	
Total Reduction (million tons)	341
Total Cost with Uniform Reduction ($ million)	359
Total Cost with Least Cost Strategy ($ million)	263
Marginal Cost of Abatement ($/ton)	1647
HC	
Total Reduction (million tons)	28
Total Cost with Uniform Reduction ($ million)	12
Total Cost with Least Cost Strategy ($ million)	4
Marginal Cost of Abatement ($/ton)	163

Source: Harvard/ADB Environmental Quality Index Project (1996).

Water Quality Regulation

Water Quality Regulation in the PRC

One study that has looked at water quality regulation in a way that throws light on the choice of the regulatory instrument is Dasgupta et al. (1996). The authors estimated joint abatement cost functions for four categories of pollutants: total suspended solids (TSS), chemical oxygen demand (COD), biochemical oxygen demand (BOD), and other pollutants. Data were taken from 260 enterprises in the PRC (Beijing and Tianjin), some of which had multiple sources, for a total of 370 observations. Within this sample the extent of abatement varied considerably, from none to nearly 100 percent, with a median level of abatement of 70-80 percent. Hence the sample was well-suited to estimate the cost functions giving the marginal cost of removing each of the four pollutants referred to above. Various functions were fitted to the data. Of these, the simple log-log form appeared to work as well as more complex specifications, which meant that deriving the total cost function or the response of effluent levels to a charge is particularly easy.

The data show that the marginal costs of abatement vary considerably by industry, by size of plant, and by level of abatement. Table 5 reports some of the findings on these costs. The implications of these large variations is that a system of market-based instruments is likely to yield large benefits compared to a CAC system that imposes uniform regulations on all polluters.[9]

Table 5: **Marginal Abatement Costs for Different Industries for Water Effluent in the PRC**
(US$/ton)

	Small		**Medium**		**Large**	
	10% Abatement	**60% Abatement**	**10% Abatement**	**60% Abatement**	**10% Abatement**	**60% Abatement**
Suspended Solids						
Food Processing	0.36	0.96	0.02	0.06	0.01	0.03
Textiles	0.78	2.09	0.40	1.07	0.31	0.84
Paper	0.10	0.26	0.05	0.13	0.02	0.06
Oil Refining	0.58	1.55	0.18	0.49	0.05	0.13
Chemicals	0.12	0.32	0.04	0.10	0.02	0.04
COD						
Food Processing	0.35	0.97	0.02	0.06	0.01	0.03
Textiles	0.24	0.67	0.12	0.34	0.10	0.27
Paper	0.07	0.18	0.03	0.09	0.02	0.04
Oil Refining	1.47	4.13	0.47	1.31	0.13	0.35
Chemicals	0.50	1.41	0.16	0.45	0.07	0.19
BOD						
Food Processing	0.86	2.53	0.05	0.15	0.02	0.07
Textiles	1.01	2.97	0.52	1.52	0.41	1.19
Paper	0.26	0.77	0.13	0.38	0.06	2.18

Source: Dasgupta et al. (1996).

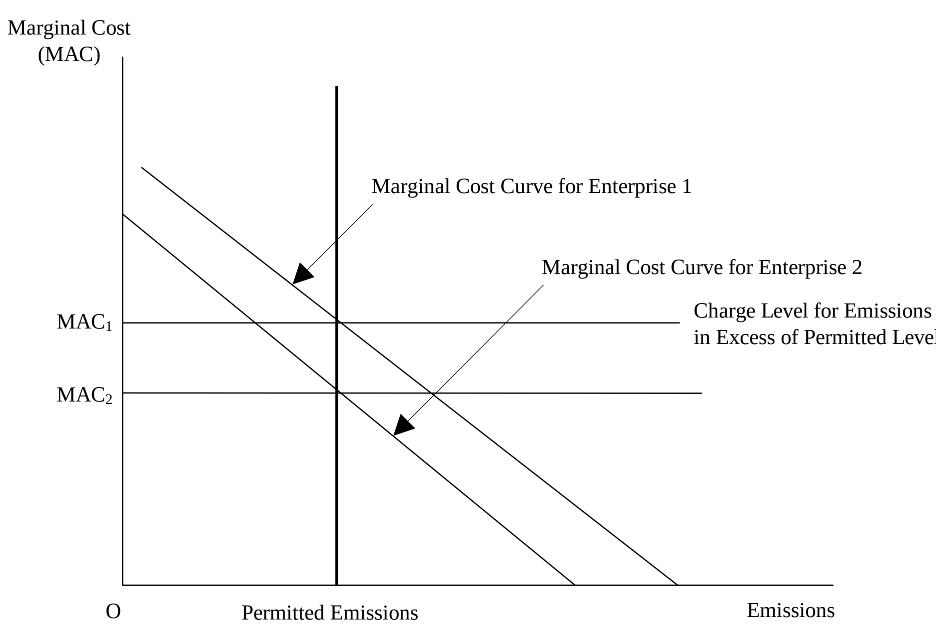
The PRC already has a mixed system for the regulation of water effluents, with charges levied on “excess emissions” and emissions up to an applicable standard for the enterprise as “free”. The permitted emissions are based on the absorptive capacity of the receiving waters but permitted emissions for a given body are more or less equal for all emitters. Hence this is one case where there is a spatial dimension to the

[9] As has been pointed out, a more appropriate assessment of the variations in marginal abatement costs is to estimate them for different levels of concentration rather than abatement. Unfortunately such data do not exist.

problem. Dasgupta et al. look at the implications of a shift to a full pollution charge system, which would meet the same water quality standards as are being met at present. This implies that they have to set the charge high enough for the standard to be met at all points of monitoring. In spite of that, the full pollution charge system is more cost-efficient. Of course the full least cost solution would set different permits for each enterprise, in accordance with local quality objectives, but that would be extremely complex to administer.

The cost saving in this case comes about because it forces the marginal costs of abatement to be equated across all enterprises. With a charge only on excess emissions, the marginal costs are not equal as can be seen in Figure 3. Enterprise 2 has a lower marginal abatement cost than enterprise 1. With the same permitted emissions, both enterprises only cut back to the permitted level. This does not, however, equate marginal costs. An increase in abatement by 2 and less abatement by 1 and 2 would achieve the same goal at a lower total cost.

Figure 3: **Marginal Abatement Costs with and Excess Charge**



MAC_1: Marginal Cost for Enterprise 1
MAC_2: Marginal Cost for Enterprise 2

Enterprise 2 has a lower marginal abatement cost than enterprise 1. With the same permitted emissions, both enterprises only reduce emissions to the permitted level. But this does not equate marginal abatement costs.

Table 6 gives the cost savings in moving to a uniform pollution charge for each of the pollutants, as well as the level of charge needed to achieve the present level of overall abatement. There is a saving of $34 million annually from this set of enterprises, a 70 percent reduction. However, these figures, although interesting and important, have to be qualified. First, the cost functions are estimated under the premise that enterprises are cost-minimizing; to the extent that they are not, the results will not be valid. Related to that, the impact of a charge may be different from that anticipated, if the estimated cost functions are incorrect.

Table 6: **Cost Savings from a Uniform Effluent Charge**
($ million)

Pollutant	**Current Abatement Rate (%)**	**Full Emissions Charge ($/Ton)**
Total Suspended Solids	93	4.00
Chemical Oxygen Demand	92	20.00
Biochemical Oxygen Demand	89	25.00
Total Cost	47.3	12.9

Source: Adapted from Dasgupta et al. (1996).

Water Regulation in the Philippines and Pakistan

As for air pollution, data on water pollution loading are available by sector for the Philippines and Pakistan. The ENRAP project gives the data for the Philippines and is reported for BOD_5 in Markandya (1997). Costs of abatement vary considerably by industry but the majority of the reported emissions come from two sources: household waste and "Sanitary and Similar Services".[10] These two sectors account for about 83 percent of the waste. Hence there are very limited savings in going from a uniform reduction solution to a least cost solution ($656 versus $470 million). In such a case, the use of market-based instruments at the level of the industry will only work if there are significant intrasectoral cost differences. As Table 5 shows, however, there are indeed big cost differences at this level. Hence one can expect a charge scheme to produce much larger gains than have been reported here.

[10] The reported costs of abatement for household waste appear to be wrong in the report (they are around 40 cents per ton). The figure has been corrected by assuming a misplaced decimal place, so that actual costs are about $4/ton.

For Pakistan, the data are much more limited, dealing only with a few industrial sectors. Within this set, the differences in cost of abatement are, however, significant. The cost of abatement figures are taken from cost function estimates developed for the Philippines by Yu (1995). On this basis, a 70 percent reduction in emissions would have a total cost of $86 million if undertaken on a uniform basis and $44 million if undertaken on a least cost basis. The latter gains mainly by avoiding abatement in the paper and board industries, which have the highest costs of abatement.

Conclusions on the Differences between Least Cost and Actual Environmental Policies

This section began by setting out the framework for a move to policies that will reduce the costs of environmental protection. In addition to measures to control emissions, there is considerable scope for reform through changes in economic policies that are not directly related to the environment. The most important of these is the removal of environmentally damaging subsidies. A number of examples of how the removal of such subsidies has been environmentally and economically beneficial have been given. At the same time, however, there are subsidies that can be environmentally beneficial, and a full appraisal of the impacts requires an economywide analysis. Not all subsidies can be shown to be environmentally harmful.

MBIs have a clear cost advantage over CAC instruments, in the way that most CACs are designed. This is to impose a technology or emissions standard that is constant for all enterprises, with little regard to differences in costs of abatement. At the same time, CACs can address differences in damage from different emitters better than MBIs. For this reason modern regulatory policy in OECD countries combines MBIs with CACs, the former to take advantage of the cost efficiency and the latter to address local pollution issues. This paper has focused on the cost aspect of the regulatory policy. This does not mean, however, that the importance of CACs to address specific local problems is not recognized.

The remainder of the section analyzed two important and typical areas of environmental regulations—air emissions from stationary sources and water effluent control. Both cases demonstrate the benefits to be realized from going from present polices to least cost policies. Four countries have been looked at: PRC, India, Pakistan, and Philippines. For air pollution the analysis of PRC and India is based on a set of present policies that are not known in detail, but must be considered as representing the present mix of CAC and (some) MBIs. For the Philippines and Pakistan, the CAC policies are assumed to be a uniform percentage reduction in emissions from all sectors.

The analysis shows considerable gains from moving to a least cost solution. In fact the reported “least cost” solution will not be the true least cost, because the data do not provide detailed abatement costs at the enterprise level. Instead it has been necessary to take average costs of abatement for each industry (with some limited intrasectoral variation). This means that the differences between the least cost and the CAC solutions will be underestimated, more so when the sectoral costs are for wide sectors, or do not allow for intrasectoral variation. On the other hand, CAC solutions may not be as simplistic as those shown here. Extending the analysis to both these factors is difficult but, as other studies have shown, the cost advantage of the MBIs is retained in the more complex case.

In the other case (water) the present policy is a known combination of discharge permits and charges on excess emissions. The PRC data show that, even with limited MBIs, the move to more effective MBIs can yield major cost savings. Here the charge scheme that is replacing the present system has to meet given water quality standards, which implies that the local or spatial dimension has to be addressed in the MBI. In spite of that it is more cost-effective than the crude MBI.

The data from the Philippines show, on the other hand, that the savings in going to a least cost solution may not be that large, if the pollutants are concentrated in one or two sectors. Conversely, if one sector has very high abatement costs, excluding it from the reductions can capture much of the benefits associated with the move to a least cost solution (as can be seen from the Pakistan data).

In order to obtain the least cost solution, the appropriate MBIs have been identified. These will get one closer to the least cost, but not completely to it. The measures needed to make the MBI as effective as possible have also been identified. These require both professional competence in designing the MBI, but also the political will to implement it. The next section considers the problems with both aspects of policy reform, and looks at the institutional changes required to move more effectively toward an MBI-based regulatory system.

Institutional Reforms

Obstacles to Greater Adoption of MBIs

Before one can discuss the institutional reforms necessary to increase the emphasis on MBIs it is necessary to understand what are the obstacles to the implementation of these policies. After all, economists have been writing on the advantages of such policies for some time. Why then are they not more widely adopted?

Whatever the merits of economic incentives and the experience in developing countries with their use, considerable obstacles prevent their wider adoption. These are discussed below.

Lack of Knowledge of How MBIs Work and Their Effects

There is a lack of understanding on how these systems work and on their impact on growth and income distribution. Often, they are dismissed as ways to appropriate poor peoples' resources or to reward polluters with a legal right to pollute. Some fear that economic incentives will raise the costs of production and make local industries less competitive in world markets. Because these systems raise the cost to the public, governments are concerned that they will be unpopular and government stability might be compromised. Command-and-control regulations appear safer, even if they are not cost-effective.

These political concerns constrain not only the introduction of economic instruments, but also their effectiveness. Their limited acceptance has led to some charges and taxes being introduced with rates set at levels too low to change behavior. While it is necessary for initial charges to be set low to elicit wide acceptance by industry and provide time for adjustment, a predictable schedule of escalation to meaningful levels must be provided to shape expectations, influence investment decisions, and stimulate innovations.

Soft Budget Problems

Economic instruments are likely to be most effective where economic agents respond sensitively to changes in incentives, in the light of the pressures on them to minimize costs and maximize profits. From the experience of socialist countries such as the PRC, one can see that complex and sophisticated systems of pollution charges may be ineffective in conditions where such charges have no influence on the aims that are actually pursued by managers, which may be only loosely connected to cost control and profit maximization. This problem will be most significant in countries where a substantial part, or even the majority, of major industrial enterprises is in parastatal control.

Cultural Factors

There is another aspect of the special characteristics of governance in developing countries that casts a different light on the above argument. In highly industrialized societies, taxation of environmentally damaging behavior is seen as an economic instrument, as opposed to the command-and-control instrument of legal regulation backed by fines. It is characteristic of many developing country situations, however, that the distinction is less clear. The decision to notice a breach of the law and to prosecute it is delegated to very low levels. In other words, ordinary policemen, customs officers, and minor officials frequently extract informal payments for disregarding offenses, or even for not inventing offenses. In these situations the distinction between regulations and fines on the one hand, and taxation on the other becomes blurred. The disadvantage of such informal "taxation" from the economic point of view remains, however, that the "price" of environmental nuisance becomes highly variable between economic agents, and highly unpredictable. It therefore loses the advantages of taxation as an instrument. On the other hand, entrepreneurs are used to paying for environmental privileges, and so a shift to a more formal system of taxation should be easier to make.

Economic/Institutional Obstacles and How to Overcome Them

Successful use of economic instruments in developing countries requires that a number of conditions be met. The important ones are:

(i) *Knowledge and Awareness of Instruments*. The agency responsible for environmental policy must have technical knowledge to formulate and implement economic incentives, and polluters must have the knowledge to respond appropriately. If MBIs are to be adopted more widely, policymakers have to be convinced of their merits. This requires the kind of in-depth study referred to above, but it also requires key concerns of elected officials to be answered. These include (a) the distributional implications of the use of MBIs, (b) the implications on output and employment in the affected industries, (c) costs of implementing such measures, and (d) the international trade implications of the measures. All these can be addressed, but doing so implies a careful study of one or more instruments to meet clearly stated objectives. Presenting the results of the research simply and clearly is also important.

(ii) *Good Governance***.** The legal structure must define property rights adequately and establish the authority to implement and enforce incentive systems. The system needs to be clear and predictable. As set out by the Business Council of Sustainable Development, under the criteria for the choice of instruments, the regulation should offer a level playing field, so that comparable enterprises are treated equally. Furthermore, it must be possible to see whether companies or other actors comply with regulations.

(iii) *Competitive Markets.* Economic incentives are ineffective without reasonably competitive markets. If firms are operating under soft budget constraints they will not respond as effectively to fiscal incentives as when they are obliged to make profits. In competitive conditions this implies cost minimization, which is the driving force behind the MBIs. Equally if firms have monopoly power, the MBIs may be less effective; although the profit motive is there, the imperative to minimize costs is not as strong.

(iv) *Financial and Administrative Capacity*. The responsible government agency must have the financial and administrative capacity to initiate, monitor, and enforce incentive programs. In many developing countries, the environment ministries lack skills and manpower for effective regulation of environmental pollution. This is an area where technical assistance is critical and some ADB programs provide an important contribution. At the same time national governments must be encouraged to fund these important ministries better than they do at present.

(v) *Flexibility of Response*. The private sector and consumers need to be able to choose how to respond to regulation. Flexibility may be compromised if access to alternative technologies is limited (e.g., through import restrictions), if there are infrastructure bottlenecks, and if institutional structures are too rigid (e.g., they cannot adapt to a policy that requires common treatment facilities for several enterprises).

Economic incentives that meet these five conditions reasonably well have a chance of success.

Implementing Institutional Reforms

The introduction of market-based instruments has to proceed in stages. It is not possible, or desirable, to implement a complex new instrument without allowing for a learning phase. Every application has its own peculiarities, which can only emerge with time.

The experience of countries such as the US have been that piecemeal introduction offers both regulators and those being regulated a chance to learn. Furthermore, it provides an opportunity to demonstrate the benefits of the instrument in reality, and on a small scale, before extending it widely. The PRC experience of introducing SO_2 taxes in selected regions is useful in a large country, but care must be taken in interpreting the results, especially if the enterprises see it as a temporary measure.

The following steps are recommended before introducing a new market-based instrument:

(i) Carry out a careful analysis of its impacts versus the impacts of other methods of regulation. If there are parties that would be seriously or adversely affected, compensating measures may need to be introduced, at least for a temporary period. Account should be taken of the competitive conditions that exist for any MBIs to be effective. A range of alternatives should be examined at this stage, from direct controls to various kinds of MBIs. In some cases the appropriate measure may simply be removal of a damaging subsidy, in others the taxation of inputs that have damaging consequences.

(ii) Once a policy has been agreed on in broad terms it is important to obtain public awareness about it and incorporate public input in its detailed design. The results of this analysis should be made available to all affected parties, who should have a chance to express their opinions.

(iii) Legal instruments must be firmly in place for the instrument to be enacted and enforced. Authorities must have the requisite powers to ensure compliance and the rules should be set out and adhered to. If regulations are likely to get stricter it is always better to announce this well in advance, with as much detail as possible.

(iv) The authority responsible for enforcement should be given enough resources to carry out its task. Too often this is not the case, and the polluters are able to ignore the regulation because inspectors are never able to check on them.

Once the regulatory policy has been adopted it is important to review its effectiveness from time to time, and to let it evolve, so that it becomes better designed and suited for the purposes for which it is intended. This is all the more important in a dynamic and changing environment, such as Asia is currently experiencing.

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