Using Alternative Regulatory Instruments to Control Fixed Point Air Pollution in Developing Countries: Lessons from International Experience

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Abstract

Should developing countries eschew conventional command and control regulatory instruments that are increasingly seen as inefficient and rely instead on 'alternative' instruments based on economic incentives and community pressure? This paper addresses this question as it pertains to fixed point air pollution. The paper discusses the theoretical advantages and disadvantages of alternative instruments, reviews both industrialized country and developing country experiences with them, and proposes a number of policy guidelines. We argue that regulators in developing countries typically operate under severe financial and institutional constraints. Given these constraints, pure economic incentive instruments are generally not practical since they involve relatively high administrative and political costs. Suitably modified however, emissions fee policies probably are appropriate. Such policies can provide a foundation for a transition to an effective high-fee system, and can raise much need revenue for environmental projects and programs. In addition, 'indirect' instruments like taxes on dirty inputs may be a second-best approach to pollution abatement. Finally, a variety of relatively low-cost policies are available to strengthen pressures placed on polluters by private-sector agents. At very least, these policies can complement formal regulation.

Key Words: market based instruments, economic incentives, informal regulation, developing country, industrial air pollution

JEL Classification Nos.: Q25, Q28, O13

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USING ALTERNATIVE REGULATORY INSTRUMENTS TO CONTROL FIXED POINT AIR POLLUTION IN DEVELOPING COUNTRIES: LESSONS FROM INTERNATIONAL EXPERIENCE

Allen Blackman and Winston Harrington[1]

1. INTRODUCTION

Financial, institutional and political constraints make environmental regulation in developing countries far more problematic than in industrialized countries. Yet, regulators faced with the daunting task of crafting effective regulatory regimes in the Third World have at least one advantage over their historical counterparts in the West -- they have several decades of environmental regulatory history to learn from.

What lessons can be distilled from this history? In particular, does it imply that developing countries should eschew conventional command and control policies that, while often effective, are increasingly seen as inefficient, and should rely instead on 'alternative' regulatory instruments such as emissions fees, emissions permits, and public disclosure?

This paper reviews international experiences with such alternative instruments to distill lessons for regulating fixed point air pollution in developing countries. The next section describes the different types of regulatory instruments, and briefly reviews the theoretical and practical advantages and disadvantages of each. The third section surveys international experiences with alternative instruments in regulating fixed point air pollution, and distills lessons for developing countries. The last section sums up and develops policy recommendations.

2. APPROACHES TO FIXED POINT AIR POLLUTION REGULATION

Environmental regulatory instruments can be classified according to three criteria: (i) whether they dictate abatement decisions or simply create financial incentives for firms to abate, (ii) whether they require the regulator to monitor emissions, and (iii) whether they involve government investment in abatement infrastructure.

Regulatory instruments that dictate abatement decisions are known as 'command and control' (CAC) regulations. Examples include emissions standards and technology standards. Policies that create financial incentives for abatement by putting an explicit or implicit price on emissions, but which do not dictate abatement decisions, are referred to as 'economic incentive' (EI) policies. The three chief examples of such policies are emissions fees, wherein firms pay a fee per unit of emissions; marketable permits, wherein firms are assigned "allowances" to

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emit a certain amount of pollution which they may trade with other firms if they wish; and environmental taxes, which are simply taxes on the inputs used by polluters or outputs produced by them. (Note that our use of the terms 'fee' and 'tax' is somewhat arbitrary -- these terms are used interchangeably in the literature. Nevertheless, here we will use the term 'fee' to refer only to charges on emissions, and the term 'tax' to refer only to charges on pollution intensive inputs and outputs.)

Policies that require the regulator to monitor emissions are called 'direct' instruments and policies that do not are called 'indirect' instruments (Eskeland and Devarajan, 1996). Emissions standards, emissions fees, and marketable permits are examples of direct instruments while environmental taxes and technology standards are examples of indirect instruments.

All the policies mentioned so far do not involve government investment in abatement. Examples of policies that do include paving roads and constructing solid waste dumps to control releases of particulate matter.

The three criteria discussed above imply a classification scheme that is summarized in Table 1 (Eskeland and Jimmenez, 1992).

Table 1. The menu of environmental regulatory instruments

	Direct Instruments	Indirect Instruments
Economic Incentives	• emissions fees • marketable permits	• environmental taxes
Command and Control	• emissions standards	• technology standards
Government Investment	• road paving • waste disposal plants	• R&D in clean technologies

2.1 Direct vs. Indirect Regulatory Instruments

The standard in industrialized countries, direct instruments often have little impact in developing countries because they require a central authority capable of establishing rules for the conduct for polluting sources (whether emission fees, tax rates, or technology standards), monitoring performance with respect to those rules, and enforcing compliance. In many developing countries, financial and institutional constraints undermine these capabilities -- technical expertise is limited, funding is chronically scarce, production is often dominated by hard to monitor small-scale firms, complementary judicial, legislative, and data collection institutions are weak, public sentiment favors economic development over the environment, and industrial interests often have more influence on public policy than environmental activists. Given these constraints, indirect instruments stand a better chance of being effective.

Perhaps most popular indirect instrument is the environmental tax. In general, such taxes are much easier to administer than emissions fees or standards since quantities of goods are usually much easier to monitor than emissions, and since in most cases, government tax collection agencies already exist. Taxes have the additional benefit of generating revenue that

can be used to defray administration or abatement costs. In fact, this has generally been their principal purpose.

There are at least two important disadvantages of environmental taxes. First, since they do not target pollution directly, environmental taxes do not create incentives for pollution abatement per se. For example, an electricity tax may reduce pollution by lowering electricity production but would not provide incentives for producers to produce more cleanly. A coal tax might be more effective since it would create incentives for plants to use clean fuels such as natural gas. Basing the coal tax on sulfur or ash content would be better still, since it would provide incentives for the use of clean coal in addition to coal substitutes. Still, no environmental tax could create incentives for power plants to install or maintain scrubbers, since plants with scrubbers pay the same unit tax as those without it.

A second disadvantage is that for taxes on polluting inputs to be effective, firms must have access to less-polluting substitutes. When substitution is costly, tax increases must be quite large to cause an appreciable reduction in emissions.

One solution to the first problem is to combine a tax with an emissions standard or technology standard. The resulting hybrid policy can be more effective and more efficient than either the tax or the standard alone (Eskeland and Devarajan, 1996). However, as discussed below, it is difficult to establish source-specific emissions standards efficiently and to monitor compliance with emissions standards.

Rather than tax pollution-intensive products, often all that is really needed is to simply remove subsidies. In Central and Eastern Europe, for example, removing long standing fuel subsidies initiated during the Soviet period has probably done more to improve environmental quality than any explicit environmental policy.[2]

We note that constraints on direct regulation are likely to be relaxed over time due to economic growth and "institutionalization." This raises the question of whether and how it might be possible to plan for a transition to an environmental policy that relies on direct instruments. We return to this question below.

2.2 Economic Incentive versus Command and Control Instruments

Economists have long argued that EI instruments are superior to CAC policies in terms of static efficiency, dynamic efficiency, and flexibility. These efficiency advantages would appear to be especially attractive to developing countries given that financial and administrative resources are in short supply.

The static efficiency advantages of EI instruments stem in part from the fact that they only create financial incentives for individual firms to abate but leave then free to choose abatement technologies that minimize costs given their *individual* circumstances. By contrast,

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[2] According to Steer (1992), removing energy subsidies in Central and Eastern Europe would cut air pollution by half. However, subsidies do not always affect environmental quality adversely. Eskeland et al. (1994) found that energy subsidies in Indonesia tended to *favor* the use of cleaner fuels, and that the removal of these subsidies could have adverse environmental effects.

under CAC technology and emissions standards, the regulator more or less dictates that whole classes of firms chose certain technologies.[3]

Perhaps more important for static efficiency, EI instruments create incentives for individual firms to choose levels of abatement such that aggregate costs of achieving a given level of environmental quality are minimized. Specifically, firms with low abatement costs are driven to undertake more abatement than those with higher abatement costs. In emissions fee programs, firms whose marginal abatement costs are lower than the fee will abate, while those whose marginal abatement costs are higher than the fee will not abate; they will pay the emissions fee instead. In marketable permit programs, firms with abatement costs below the market price of permits will abate and will sell their emissions permits while those with marginal abatement costs above the permit price will not abate; they will purchase permits instead.[4] This type of behavior is probably sufficient by itself to make EI policies more cost-effective than most CAC policies. For a CAC policy to achieve the same result, the central authority must know the marginal abatement cost of every polluter, which is extremely unlikely in practice.[5]

Although "static efficiency" arguments are the ones that are usually brought to bear by advocates of EI instruments, the advantages of dynamic efficiency and flexibility may be of greater long-run importance. Because firms in EI programs can always increase profits by reducing emissions, such programs provide continuing incentives for emission-reducing innovation. By contrast, in a CAC system, the incentive to innovate is often offset by the enforcement risks associated with using a non-approved technology and the risk that a well-performing new technology will serve as the technology-based standard in a new round of CAC rulemaking -- the so-called "regulatory ratchet."

Finally, EI regimes are more flexible than CAC regimes, that is, they more easily accommodate change, whether of environmental standards, economic conditions, or abatement

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[3] Though CAC emissions standards do not explicitly dictate firms technology decisions, in practice they usually create strong incentives for firms to choose only officially sanctioned technologies and can therefore be regarded as "technology forcing." In the United States, emissions standards on point sources administered under both the Clean Air Act (e.g., Lowest Achievable Emissions Rates) and the Clean Water Act (e.g., effluent guidelines) are technically performance standards but are developed with reference to the abatement capabilities of specific technologies. Hence, firms that want to minimize their risks of being found in violation of such standards will want to adopt the technologies underlying the standards. The potential for paying a high penalty for using alternative, innovative, but riskier approaches to meet performance goals turns a *de jure* performance standard into a *de facto* technology standard.

[4] More technically, in both types of EI programs, in theory the marginal abatement costs of all firms are equated; each source abates to the point where the marginal cost of further abatement equals the either the fee or the permit price. The equalization of marginal costs is a necessary condition, in the standard theoretical model, for least-cost emission reductions. The extent to which real world EI policies resemble the theoretical ideal is discussed in next section.

[5] In the U.S. at least, most CAC policies adopted before 1990 did not even attempt to achieve cost-effective emission reductions. The most important economic considerations were distributional: to avoid shutting down plants, to give breaks to small facilities, to treat existing facilities more leniently than new ones. Magat et al. (1986). An additional advantage of economic incentive policies is that in responding to them firms inadvertently reveal information on what their abatement costs are. The information revealed is extremely valuable in making policy adjustments or in extending the instrument to other regions or other pollutants

technologies. In a CAC system, the regulator must formulate and promulgate thousands of rules concerning different types of sources. Moreover, if the U.S. is any indication, over time a CAC environmental policy tends to become more and more complicated, as layers of regulation are added to deal with new problems and new information. Changes to the regulatory regime take an inordinate amount of time and effort.[6]

By contrast, in an EI system, firms retain control over facility-specific abatement decisions while the regulator simply sets fees or permit quantities to achieve an environmental quality standard. As a result, changes in response to new technologies and economic conditions are spontaneous and decentralized -- the regulator need take no action at all. Changing the environmental quality standard is also relatively simple. In an emissions fee system, all that is required is to change the fee or fees. In a marketable permit system, all that is required is to change the quantity of permits.[7]

A brief note on the choice between emissions fee and tradable permits policies. Emissions fees allow the regulator to control abatement costs, but not emissions quantities, while tradable permit systems allow the regulator to control quantities but not costs (Weitzman, 1974). Given that concerns regarding costs are likely to trump concerns regarding environmental quality in most developing countries, fees systems would seem more appropriate than tradable permits.

2.3 The Continued Primacy of Command and Control

Despite strong theoretical arguments and some empirical evidence of the advantages of EI over CAC approaches, it is striking how infrequently EI policies are encountered, even in countries with strong free-market traditions. Worldwide, almost all countries have adopted CAC policies as the primary means of controlling pollution. Even when EI programs are found, they frequently combine elements of CAC. As the experiences detailed below make clear, what pass for EI instruments are frequently "mixed" systems that combine emissions fees with emissions standards wherein sources pay a (possibly zero) fee up to the standard and then another higher fee for emissions above the standard.[8] Why have EI instruments not been applied more often?

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[6] For example, in the U.S., attempts to change just one CAC source emission standard, whether the Effluent Guidelines under the Clean Water Act or the New Source Performance Standards of the Clean Air Act, have generally been very time-consuming and expensive.

[7] Reducing the number of permits in response to a demand for environmental improvement is administratively simple, though potentially costly to the government**,** since it may require the government to purchase permits. Actually, it is possible to build gradually improving environmental quality into a marketable permit system by giving some of the permits expiration dates.

[8] Such mixed systems were first proposed as a way of improving on the efficiency of emissions fees or marketable permits when there is a great deal of uncertainty about the firms' abatement costs. They were first analyzed by Roberts and Spence (1976). In their treatment, the emission limits were themselves tradable. While that feature may enhance the theoretical efficiency of the policy, it is not an essential element.

At least three factors are relevant. First, the principal selling point of EI policies -- improved economic efficiency (generally understood to be the maximization of the sum of benefits less costs) is something that decision-makers do not seem to care much about since there is rarely a constituency for maximization of efficiency as such. Instead, there is usually tremendous pressure to assure that benefits continue to accrue to the current "winners" (Buchanan and Tullock, 1975).

The difficulties created by such distributional concerns are particularly striking in the context of emission fee policies. Although fees can achieve emission reductions at the least cost to society, they are not usually opposed by polluters who must pay the fees in addition to abatement costs. Unless the fees are returned to polluters, instituting a fee system implies a potentially important income redistribution.[9]

A second reason for the persistence of CAC policies is that the monitoring requirements may be less demanding than those associated with EI policies. For example, a CAC technology standard only requires evidence that the designated abatement technology has been installed.

In practice, even the monitoring requirements for CAC emissions standards are not very stringent. Usually CAC standards are written in terms of some instantaneous or short-period emission rate. This would seem to imply that continuous emissions data is required. But, at least in the United States, the difficulties of accurately monitoring emissions often (but not always) cause the authorities to settle for a two stage effort -- early monitoring ensures "initial compliance", and subsequent periodic monitoring ensures "continuous compliance" (Russell et al., 1986). Often regulators adopt a fairly informal "voluntary compliance" process, in which violators are encouraged to report violations and are given a chance to return to compliance without appreciable penalties. This process works reasonably well as long as sources act in good faith. One of the reasons the system works is that emission sources tend to install emission control equipment in excess of what is needed to meet standards, often by a substantial margin (Arora and Cason, 1995).

It is not clear that this sort of second-best monitoring would work for EI instruments that would seem to have more demanding monitoring requirements. In emissions fee systems, monitoring data are used to computing fees so monitoring must be accurate to avoid jeopardizing political support. In tradable permit systems, the viability of the permit market depends critically upon firms' faith that the regulator reliably enforces emissions limits implied by the permits. Also, in a permit system there is less likelihood that firms will "overcontrol" emissions, because such slackness would represent emissions that they could sell to other firms.

A third reason for the persistence of CAC policies is inertia -- in most countries CAC policies are the status quo. In the United States, a great many consulting firms, lawyers and employees of governmental and quasi-governmental agencies form a strong constituency for keeping clean air policy the way it is. This inertia might be easier to overcome if CAC approaches had obviously failed to improve air quality. But they have not. The air quality improvements observed in the U.S. and elsewhere might have been achieved at much lower

[9] If fees are returned to polluters then it has to be done in some way that does not affect abatement incentives.

cost using EI approaches, but that is an argument that is not likely to impress those whose minds must be changed before the policy can be changed.

2.4 Government Investment

Government construction and operation of abatement facilities seemingly avoids the difficulty of monitoring the performance of polluters. Such facilities are perhaps less suited to air pollution than to water pollution. Publicly-owned wastewater treatment facilities are the norm in most industrialized countries and publicly-operated municipal waste incinerators are common.[10]

Yet government ownership and operation is not a guarantee that facilities will be operated in an environmentally benign manner. Like their counterparts in the private sector, managers at government facilities must be concerned about competing objectives such as output targets and budget constraints. In fact, there is some evidence that government owned facilities are dirtier than private ones, perhaps because they are insulated from regulatory oversight. Some of the most environmentally troubled facilities in the United States have been government owned, including fossil and nuclear power plants operated by the Tennessee Valley Authority and weapons storage facilities operated by the Defense Department. Still more compelling examples are provided by the countries of Eastern Europe and the former Soviet Union where government ownership of production did little to prevent severe environmental degradation.

2.5 Informal Regulation

As discussed above, a broad range of financial and institutional constraints undermine state-sponsored environmental regulation in the Third World. Yet in many developing countries, some firms over-meet *de facto* lax local standards. In part, this is due to "informal regulation" -- pressure exerted on polluters by private-sector groups such as community organizations, environmental advocacy groups, and trade unions. According to Pargal and Wheeler (1996), informal regulation relies on, among other things: "social pressure on workers and managers, adverse publicity, the threat of violence, resource to civil law, pressure through politicians, administrators or religious leaders." It may work best in open societies where government can not prevent workers or advocates from identifying and publicizing environmental problems. Democratic institutions at both the local and national level are also important for it is ultimately the fear of rejection at the ballot box that induces politicians to respond to public opinion.[11] A growing body evidence suggests that informal regulation can be an effective substitute for formal regulation in developing countries.

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[10] It should be noted that public wastewater treatment facilities often accept waste from private firms whose waste may require monitoring.

[11] In fact, it is quite likely that a tradition of successful informal regulation is more important to the development of a successful environmental regulatory regime than simply adopting the legal trappings of such regimes.

3. INTERNATIONAL EXPERIENCES WITH ALTERNATIVE REGULATORY POLICIES

This section reviews international experiences with alternative regulatory policies. Sections 3.1 and 3.2 focus on the experiences of industrialized and developing countries with EI policies. Section 3.3 reviews three case studies of the application of a broad range of policies to severe air pollution problems in Latin America. Finally, section 3.4 surveys international experiences with informal regulation.

3.1 Alternative Regulation in Industrialized Countries

Policy makers in the industrialized countries have advocated the use of EI instruments for at least two decades. During this time, industrialized countries have increasingly grafted EI policies onto existing CAC regimes. The United States and Europe favor different types of EI policies. While European countries have typically opted for emissions fees and environmental taxes, the United States has encouraged permit trading. Today, though CAC policies still dominate, almost all industrialized countries have adopted some EI schemes, and the use of EI instruments continues to grow.[12]

Opschoor (1994) provides a concise analysis of the results of a 1992 survey on the use EI instruments among OECD countries for the control of air pollution (for a more detailed analysis see Vos et al., 1994; see also, Anderson and Lohof, 1997). Sections 3.1.1 through 3.1.3 briefly discuss Opschoor's findings regarding emissions fees, environmental taxes, and tradable emissions permits. Sections 3.1.4 and 3.1.5 provide more detail about the use of EI instruments in Sweden and the United States. Section 3.1.6 summarizes and concludes.

3.1.1 Emissions fees

All twenty-three OECD member except Greece and Turkey have emissions fee programs for some mediums (not necessarily air). Though at least forty percent of these programs were intended to create incentives for emissions reductions (as opposed to having been created simply to raise revenue), less than ten percent of these have had any *discernible* impact on abatement. To be fair, in many cases this is because the relevant data is simply not available.

Six OECD countries have emissions fee programs specifically geared toward air pollution: Canada (general air pollution), France (acidifying emissions), Japan (sulfur dioxide), Portugal (sulfur dioxide and nitrogen oxides), Sweden (nitrogen oxides), and the United States (criteria air pollutants). Though the programs in Canada, Japan, Sweden, and the United States were intended to have an impact on emissions, only the Swedish program has clearly had such an effect. It is discussed in detail below.

[12] In eight countries studied by Opschoor (1994) the number of economic incentive policies grew by 50 percent between 1987 and 1994.

3.1.2 Environmental taxes

All twenty three OECD members except Spain, Turkey, and New Zealand have some type of environmental taxes (not necessarily geared toward air polluters). Though at least half of these taxes were intended to have some impact on emissions, only sixty percent actually had such an effect. This was primarily attributable to the taxes having been set too low.

OECD countries have instituted three types of taxes specifically aimed at abating air pollution: carbon taxes, sulfur taxes, and taxes on ozone depleting chemicals. Six countries levy carbon taxes: Denmark, Finland, Italy, the Netherlands, Norway, and Sweden. In three of the these countries -- Denmark, Norway, and Sweden -- the taxes were intended to have an incentive effect. All of these programs are still in their infancy and it is still too early to tell if they programs have succeeded in cutting emissions. However, in Sweden carbon taxes are very high and some heating plants have already switched from fossil fuels to biofuels as a result.

Three countries -- Norway, Sweden and Finland -- tax the sulfur content of fuels. The Swedish tax seems to have significantly reduced the use of such fuels.

Finally, three countries -- Denmark, Australia, and the USA -- tax ozone depleting chemicals. Both the Danish and American taxes seem to have had a significant impact.

3.1.3 Tradable permits

Three countries have tradable permits schemes aimed at air quality control: the USA, Canada, and Germany (the only other tradable permit programs of any type are in Sweden and Australia). The American programs are the oldest and have received the most attention. The three principal American permit trading programs are the Emissions Trading Program, the Acid Rain Control Program, and the Ozone program. In each case the programs are aimed at reducing the costs of existing CAC programs. The US Emissions Trading Program is discussed in more detail below.

3.1.4 Environmental taxes and emissions fees in Sweden[13]

As noted above, Sweden's tax and fee programs stand out among EI programs in OECD countries as having clearly changed firm behavior. This section, provides a more detailed look at these taxes.

Sweden has three EI programs geared toward abating air pollution: a carbon tax, a sulfur tax, and a nitrogen oxide emissions fee program. Initiated in 1991, the carbon tax, (presumably a tax on the carbon content of various fossil fuels and therefore, in our lexicon, a 'tax' and not a 'fee') grew out of a drastic reform of the national tax system that mainly consisted of cutting income taxes and raising value added taxes and sales taxes to offset the lost revenue. The carbon tax was set at US $10.40 per ton of carbon dioxide for industry, and

[13] Except where citations indicate differently, this section is based on Lovgren (1994). For more information on the Swedish case see: Swedish Green Tax Commission (1997).

US $41.60 per ton of carbon dioxide for other sectors. These rates are the highest in the OECD (Opschoor, 1994, 93). In 1992, the tax generated around US $1.17 billion in revenue.

It is difficult to assess the impact of the carbon tax on emissions since it coincided with other tax reforms, most importantly the extension of the value added tax to the entire energy sector and a fifty percent cut in pre-existing energy taxes – the net effect of these reforms was a substantial increase in the overall level of taxes on fossil fuels.

Sweden's sulfur tax, also initiated in 1991 as part of the national tax reform, is a tax on the sulfur content of coal, peat, and oil. The tax rate, US $3,900 per ton, was based on a calculation of the marginal cost of abating sulfur emissions and, as a result, is considerably higher than rates used in other countries. To reward firms which have installed end-of-pipe treatment systems, the tax is refunded when emissions are controlled by scrubbers. To prevent cheating, firms that claim refunds are subjected to continuous emissions monitoring. The sulfur tax supplements a pre-existing CAC regime involving permitting and emissions standards.[14]

The sulfur tax has had a strong impact on emissions abatement. Aggregate sulfur emissions decreased by twenty-five percent in the first year the tax was administered, though tighter CAC regulations and lower industrial activity undoubtedly contributed as well. More tellingly, after the imposition of the tax in 1991 but prior to the introduction of the carbon tax and more ratcheting up of emissions standards in 1993, the average sulfur content of heavy fuel oil fell from 0.65 percent to 0.40 percent. Lovgren writes, "The sulfur tax seems to have been decisive in reducing emissions from the combustion of coal, peat and gas oil in stationary sources" (112).

In 1992, Sweden imposed a fee on the emissions of nitrogen oxides from large and medium sized plants. The fee, US $5,200 per ton, together with a tightening of CAC regulations, was designed to reduce emission by thirty percent over three years. To avoid creating a competitive advantage for small firms that are exempted from the fee, the revenue from the fee is refunded to the payees in proportion to the amount of energy produced. This refund mechanism supposedly creates incentives to reduce emissions and increase energy efficiency. Most fees are calculated based on continuous monitoring which entails costs estimated at US $39,000 per plant or US $520 per ton of nitrogen oxide abated. The annual costs of administering the program are estimated at US $26 per ton of nitrogen oxide abated.

The nitrogen oxides fee has had the intended impact. Total emission from monitored plants fell by forty percent between in the first two years of the program due to improvements in combustion efficiency, installation of selective noncatalytic reduction systems, and flue gas cleaning. For most plants, there were no changes in CAC regulations during this time so most of the reduction can be attributed to the emission fee.

[14] The sulfur tax generates a negligible amount of revenue. In 1992 it generated around US $39 million.

3.1.5 Tradable permits in the United States[15]

Though both the Environmental Protection Agency's relatively new sulfur dioxide trading program and state/regional level air pollution permit trading programs have recently received considerable attention (see, e.g., Burtraw, 1996, and McCann 1996), the oldest and most important permit trading scheme in the United States is the Emissions Trading Program (ETP).

The ETP has been grafted onto a complex CAC regime for fixed point air pollution control that has three main components: national ambient air quality standards for six different pollutants, state implementation plans that specify emissions standards and other controls necessary to meet the ambient air quality standards, and best available technology standards for a variety of sources. The emissions trading program grew out of frustration with existing regulation that, if interpreted strictly, would have prohibited the building of new sources in areas not in attainment with ambient air quality standards. To accommodate economic growth under the CAC regime, the EPA established a program of "offsets" whereby new sources are allowed to locate in non-attainment zones if they are able to secure sufficient "emissions reductions credits" from existing firms. Emissions reductions credits evolved into the hard currency of a tradable permit market. By 1986, the EPA had formalized rules to allow three other kinds of transactions: "netting," "bubbles," and "banking." Netting allows old sources wanting build new facilities to avoid strict new source regulations by, among other things, applying emissions reductions credits earned in old facilities to the new facilities. Banking, instituted in 1979, allows firms to store emissions reductions credits for subsequent use. Bubbles, also instituted in 1979, allow two or more sources to be treated as if they were enclosed by a bubble, i.e., treated as one emissions source. The bubble provisions were supposed to encourage both internal and external trading of emissions reductions credits and, according to Atkinson and Tietenberg (1991), were supposed to be its centerpiece of the ETP since they most closely resembled theoretical models of emissions trading.

In general, the impacts of the ETP have been significant but much more limited than its proponents had hoped. The number of trades has been far smaller than expected. By 1986 there had been about one hundred and fifty bubble transactions, two thousand offset transactions, five to twelve thousand netting transactions, and only about one hundred banking transactions (Hahn and Hester, 1989). Moreover, most of the bubble trades were internal, that is, between firms owned by the same parent corporation. Most analysts agree that the environmental impacts of the ETP have been negligible, a result that is not surprising given that cost effective compliance with existing standards was the primary motivation for the program. Though the program has resulted in significant cost savings -- in the range $10 billion -- the savings have been lower than expected (many predicted savings of around fifty percent of total compliance costs). Moreover, the bulk of the savings have come from netting transactions which more closely resemble regulatory relief than regulatory reform (Tietenberg, 1990a).

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[15] This section is based on Kete (1994), Atkinson and Tietenberg (1991), Tietenberg (1990a, 1990b), and Hahn and Hester (1989).

Why has the ETP not performed as well as advertised? First, expectations were unrealistically high. Second, existing CAC regulations have restricted the ability of firms to make trades. For example, current rules require that no individual trade can result in increased emissions from a participating firm. This restriction rules out multilateral trades that might increase emission of some firms but reduce overall emissions. As a result, cost savings are lower. Also, ETP rules severely restrict new firms' ability to participate in trading even though under existing CAC regulations, new and modified sources have the greatest incentives to trade since they are subject to the strictest standards. Third, transactions costs for firms involved in permit trading are high, due in no small part to the administrative requirements. Fourth, firms have limited information about the market for permits. And finally, firms are often reluctant to participate in the permit market because of uncertainty about future regulation.

3.1.6 Conclusions

Thus, the use of EI instruments among industrialized countries is fairly common though, in all cases, these instruments merely supplement existing CAC regimes. This will undoubtedly continue to be the case. According to Opschoor (1994), "Nowhere is there an observable change toward replacing the basic CAC control approach with a purely economic one."

How effective have EI instruments been? With a few notable exceptions, in the aggregate, they have not had important impacts on firm behavior. In most cases, this is due to the fact that they were not intended to have an impact; more often than not, revenue generation has been the primary motivation. In those cases where emissions fees were intended to impact firm behavior but did not, their failure is usually attributable to taxes and charges having been set at too low a level.

Notwithstanding this unenthusiastic overall assessment, the OECD experience shows that economic instruments can indeed work as advertised. In Sweden, the imposition of environmental taxes and emissions fees resulted in significant reductions in sulfur and nitrogen emissions. Too, the Swedish experience with nitrogen fees seems to bear out the hypothesis that EI policies encourage innovation. In the United States, the Emissions Trading Program has saved billions of dollars in abatement costs. Thus, the US and Swedish cases illustrate that environmental taxes and emissions fees can have a significant impact on emissions and that marketable permit systems can generate significant cost savings.

But, the details of each of these "success stories" suggest that there is good reason to believe that building effective fee and permit systems in developing and transitional countries would be problematic.

The principal difficulties with emissions fees regard the level at which fees must be set in order to be effective, and the costs of administration. In Sweden, emissions fees based on marginal abatement costs were in fact quite high, (US $3,900 per ton of sulfur and US $5,200 per ton of nitrogen oxides). While abatement costs in developing countries are bound to be lower, they are still likely to be substantial. According to O'Ryan (1993), "The empirical

literature suggests that, in general, for direct taxes [fees] on emission to have an incentive effect, their level would have to be very high."

Relatively high fees present a number of difficulties in a developing country settings. Firms are bound to complain that they must pay a fee on all emissions in addition to paying to abate, and that the fees impair their ability to compete on world markets. Also, setting high fees could result in pervasive noncompliance that might eventually threaten the legitimacy of the regulatory system.

But the Swedish experience also provides clues as to how these barriers might be overcome. Sweden has instituted a number of measures that have reduced firms' compliance costs and made the fees systems politically palatable. The revenue generated by emissions fees is returned to firms (in such a way as to keep abatement incentives intact), and small firms are exempted altogether.

The second aspect of the Swedish experience that raises questions about the applicability of fee systems in developing countries is the considerable administrative costs involved. The monitoring costs associated with the Swedish nitrogen oxides fee system are estimated at US $39,000 per plant (or $520 per ton of nitrogen oxide abated) and the annual costs of administering the program are estimated at US $26 per ton of nitrogen oxide abated. These costs would undoubtedly be even higher in most developing countries with lower levels of institutional and technical capability, and it is doubtful that many developing countries would have the willingness and ability to make such expenditures.

At least three of aspects of the US Emissions Permit Trading program raise questions about the applicability of tradable permit systems in developing and transitional countries. First, even in the United States, where markets are exceedingly well-developed, the program yielded fewer trades than expected and no tangible environmental benefits. As discussed above, to a considerable extent, these failing were due to constraints imposed by the complex CAC system onto which the permit trading program was imperfectly grafted. Presumably, a developing country designing a regulatory system from scratch could avoid this pitfall. Yet, most analysts agree that imperfect information, uncertainty, and transactions costs -- all constraints that would be magnified in a developing country setting -- were also to blame. Second, permit programs in developing countries would very likely run into difficulties with high levels of concentration in some industries and spatial differentiation in abatement costs and marginal damages. Finally, by all accounts the US program has entailed significant administration costs.

3.2 Alternative Regulation in Developing and Transitional Countries

This section considers the experiences of developing and transitional countries with alternative regulatory instruments. Though EI policies (in particular, fee systems) are fairly common in transitional countries, we are aware of no cases where economic instruments have had environmental or cost saving impacts on the order of those in Sweden and the United Sates. Therefore, we devote considerable attention to assessing barriers to the use of EI

policies and the means by which these might be overcome. The cases studies discussed are Poland, Lithuania, China, Korea, and Kazakhstan.[16]

3.2.1 Emissions fees in Poland[17]

In Poland, as in most transitional countries, decades of central planning have left a legacy of serious environmental problems. Polish emissions per unit of GDP of sulfur dioxide, nitrogen oxides, and particulate matter are two to eight times average OECD levels. Air pollution is primarily caused by emissions from large stationary sources. Power plants are probably the worst polluters. Structural (as opposed to regulatory) factors that contribute to high levels of emissions include: the dominance of relatively dirty heavy industries such as metallurgy, chemical production, and mining; extremely high levels of energy intensity; and dependence on relatively low quality indigenous coal and lignite.

In February 1990, Poland enacted new environmental legislation which retained and tightened the existing CAC regime and also revamped emissions fees. According to this legislation, all sources of emissions that exceed 200 kilowatts are required to obtain a permit that specifies emissions standards designed to meet ambient air quality standards. The fee structure is two-tiered: one set fee is paid on all emissions below the emission standard, and a penalty fee ten times the normal fee is paid on all emissions above it. The fees were raised significantly in early 1993. Non-penalty fees are now US $75 per ton for both sulfur dioxide and nitrogen oxides, and US $38 per ton for particulate matter.

According to Bates et al. (1994) the increase in fees between 1990 and 1993 is believed to have stimulated emissions reductions, though some of the reductions were clearly due to economic restructuring. There is no question, however, that the fees are far below the levels required to meet the ambient air quality goals written into the 1990 legislation. The fees are probably far below the marginal cost of abatement. Recall that the Swedish nitrogen oxide fee, based on marginal abatement costs, is US $5,200 per ton. The Swedish fees exceed the Polish fees by almost two orders of magnitude (incompatible exchange rates, purchasing power parity differences, and the fact that marginal abatement costs in Poland are no doubt lower than in Sweden probably account for some -- but certainly not all -- of the differential). Poland has also experimented with trading, though mostly by allowing intra-firm bubble arrangements (see Dudek et al., 1992).

There are a number of formidable barriers to the effective application of a fee system in Poland. First, regulators do not have the financial and technical resources to monitor emissions, administer fees and enforce sanctions. Some firms are essentially responsible for monitoring their own emissions. Also, many regions are dominated by a few large industrial enterprises which have the political power to defy local regulators. They often receive waivers and subsidies or simply violate regulations with impunity. Second, coal is widely

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[16] For other case studies see Anderson and Lohof (1997) and Huber et al. (1996).

[17] This section is based on Adamson, et al. (1996) and Bates et al. (1994). For a review of pollution fee systems in central and Eastern Europe, see Vincent and Farrow (1997).

used for residential heating and therefore thousands of small polluters with very high abatement costs contribute to disproportionately to urban air pollution. Distributional concerns and the limitations on financial and institutional resources prevent these sources from being included in the fee system. Third, notwithstanding extensive privatization, many large enterprises are still state owned and still operate under soft budget constraints. Since such firms can effectively count emissions fees as operating expenses, the fees do not create incentives to abate. Fourth, political concerns prevent differentiating fees to reflect spatial variations in pollution intensities. Fifth, revenue from emissions fees is largely dedicated to paying the local regulators' operating expenses. While this creates appropriate incentives for the collection of fees, it also creates perverse incentives to prevent abatement. Finally, fees have been continuously eroded by inflation.

To overcome some of these barriers, Bates et al. (1994) recommend a pursuing a 'mixed' regulatory system. Specifically, they recommend a ban on the use of dirty fuels by small sources in urban areas and a combination of increased emissions fees, tradable permits, and CAC regulation for large polluters. Also, they note that the removal of long-standing subsides on dirty fuels along with continued privatization should contribute to emissions reductions.

3.2.2 Emissions fees in Lithuania[18]

Many of the characteristics of the Polish regulatory regime (both good and bad) are found in other transitional countries including Lithuania. Lithuania has a mixed regulatory system that incorporates both CAC and EI policies. According to a January 1992 Environmental Law, stationary sources are required to obtain permits specifying emissions standards for over 100 different pollutants. Standards are based on the firm's own -- usually unquestioned -- calculations of the costs and feasibility of emissions reductions. Fees are charges on all emissions. Like Poland, Lithuania has a two-tiered fee system. However, the differential between the level of the fee charged on emissions below the emissions standard and those above it is far greater than in the Polish system. Revenues from the fee system are negligible, contributing only one tenth of one percent of total public revenue. They are split between the state government (thirty percent) and the Municipal Environmental Fund (seventy percent) which uses them to construct treatment facilities.

There is not a great deal of evidence on how firms have responded to the fee. According to Harrington (1993), it is likely that when the fees system was first established, to the extent it was enforced, it operated like a CAC regime in that firms paid negligible fees on emissions below the emissions standard and very large penalty on emissions above it. Later, inflation eroded the real value of the penalty fees and the system probably ceased to created any incentives at all.

[18] This section is based on Harrington (1993).

Clearly the Lithuanian fee system has been stymied by many of the same problems that confront the Polish system – the fees are set too low to have much effect, inflation has degraded the real value the fees over time, and enforcement and monitoring have been spotty.

3.2.3 Emissions fees in China[19]

China has severe air pollution problems. Levels of pollutants exceed World Health Organization guidelines in most large cites. As in Poland, the principal contributors to this problem are a multitude of aging state owned dirty industries and a heavy dependence on coal for primary energy. In addition, economic reforms introduced in 1978 have sparked rapid economic growth.

China's first Environmental Protection Law, passed rather belatedly in 1979, established a mixed regulatory system based on both emissions standards and emissions fees. Since this time, the fee system has been revamped by the promulgation of interpreting rules in 1982, and the passage of a new Environmental Protection Law in 1989. By law, polluters pay a fee only on those emission in excess of a standard. Fees are set by the central government, though in theory, provincial and local governments have some power to raise them. Firms that violate emissions standards for more than three years are assessed a fee increase. For plants built prior to 1979 the amount is five percent per year. For plants built after 1979, the amount is one hundred percent per year. Emissions standards are enforced via periodic unannounced monitoring visits (Krupnick, 1991). Fines may be imposed for failure to pay fees, for false reporting, and for interfering with inspections.

The revenue from the fees is not insignificant. Revenues totaled $1,200 to 1,700 per enterprise in 1993, about one tenth of one percent of total output. Some of the revenue is used to subsidize pollution control projects for the firms that pay into the system. It accounts for about eight percent of total capital investment in pollution control. Local Environmental Protection Bureaus may use twenty percent of the fee and one hundred percent of the fines to fund their operations.

The fee system has had some effect on abatement but the key incentives are provided by the CAC regulations. According to Florig et al. (1995) the most important accomplishment of the fee system has been to finance the operating expenses of local regulators. The effectiveness of the fees had been limited by many of the factors discussed above. First, fees are set relatively low, often lower than operating and maintenance costs of pollution control equipment. Second, the fees are not indexed to inflation so that their value has been eroded over time. Third, firms have no incentives to reduce emissions below the legal standards since fees are only paid on emissions that exceed the standard. Fourth, fees are meaningless to state owned enterprises with soft budget constraints. Fifth, enforcement has been weak. Unprofitable enterprises are usually able to escape paying by appealing to local authorities. Enforcement is especially weak for medium and small-scale enterprises, most notably China's eight million township and village industrial enterprises (TVIE's) that

[19] Except where noted, this section is based on Florig et al. (1995).

account for about one half of total industrial output and that are the major source of pollution in rural areas. Finally, the use of fees to fund operating expenses of local regulators creates perverse incentives.

3.2.4 Emissions fees in Korea[20]

Amendments to Korea's Environmental Protection Act in 1983 and 1986 gave regulators the authority to impose a fee on firms' emissions in excess of preexisting standards. Typically, however, these fees are set far below abatement costs so that firms usually prefer to pay the fees rather than abate emissions. Also, since the fees are only paid on emissions in excess of the standard firms have no incentive to reduce emissions below the standard.

3.2.5 Proposed permit trading in Kazakhstan, Chile, and Mexico[21]

We know of no operating air pollution permit trading systems in the Third World. However, regulators are attempting to set up such systems in at least three cities: Almaty, Kazakhstan, Santiago, Chile, and Mexico City, Mexico. In Almaty, non-compliance with existing CAC air pollution standards and non-payment of taxes and emissions fees are common. Local authorities plan to simultaneously step up enforcement and to set up a permit trading program to lower compliance costs. Twelve hundred fixed sources in the city will be allocated permits based on their average annual emissions between 1991 and 1994. These permits will be valid for five years, but the maximum emissions for each firm will be reduced by seven percent each year. Firms that are able to reduce emission by more than seven percent per year will be allowed to either bank the surpluses or to sell them to other firms. Firms in particularly polluted areas who wish to trade with other firms outside that "hot spot" will have to pay a premium to do so. The city will monitor emissions on a regular basis. All participating enterprises will be charges fees that will be used to finance monitoring and enforcement.

In Santiago, Chile, a 1992 decree created the legal framework for a trading system for fixed-source emitters of particulates (PM10) that was supposed to begin operation in 1997. Implementation has been delayed by at least three serious problems. First, the initial allocation of permits has created a great deal of controversy. Second, the legal basis for the trading systems has been challenged and is now considered inadequate. And finally, the delays in implementation have created a great deal of doubt regarding enforcement.

In Mexico City, a 1994 regulation allowed for the creation of "local bubbles" within which stationary sources could trade Sulfur Dioxide permits. The markets for these permits were slated to begin operation in 1997. One such bubble encompasses Mexico City. As in Chile, implementation has been delayed because existing regulations are considered inadequate.

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[20] This section is based on O'Connor (1994), chapter 5.

[21] This section is based on Panayotou (1995) pp. 20-22, and Huber (1996). For more details on Kazakhstan, see Margolis, Triveti, and Farrow (1995).

3.2.6 Conclusion

Common threads run though all of the case studies presented above. Emissions fee systems are fairly common while permit trading systems are not. In general, emissions fee systems have had limited impacts on abatement. The reasons are fairly similar in every case: fees are set at a low level and are often eroded by inflation, monitoring and enforcement are weak, state owned enterprises with soft budget constraints are effectively exempted from the fees, two-tiered fee structures dampen incentives to abate below the cut-off emissions level, and both distributional concerns and monitoring constraints prevent the inclusion of small and/or economically fragile firms. The fact that these characteristics are so common suggests that fee systems may be difficult to implement in developing countries.

Yet, there are several aspects of the case studies presented above that argue in favor of promoting their establishment in developing countries. First, the fact that fee systems have been put in place in so many countries is a positive indication since their mere existence of the systems is probably useful in itself. Once a fee system is in place, regulators may be able to raise fees and strengthen enforcement over time, a strategy that may minimize resistance to establishing a high-fee system. In other words, even low fees with negligible impacts provide regulators with a "foot in the door." By the time high fees are politically feasible, marginal abatement costs may have risen making the costs savings that accrue to a fee system more attractive. Second, most fee systems provide valuable revenue to finance operating expenses for regulators and direct investment in environmental projects.

Several of the case studies suggest useful strategies for implementing fee systems in low income settings. First, at least two countries discussed return some of the fee revenue to the payees in a manner that reduces the cost of participating but keeps abatement incentives in place. Second, in two of the cases above, sources with particularly high abatement costs -- those that are old or small -- are exempted from fees or otherwise allowed some 'slack.' This lowers aggregate abatement costs and preempts some political opposition. Third, every country surveyed has a two-tiered fee structure: the level of the fee depends on whether or not emissions meet a certain standard. This structure preserves some of the benefits of a fee system (the "foot in the door benefit" if not the incentive benefit) while reducing resistance based on the complaint that firms must a pay fee on all emissions in addition to having to pay to abate. Fourth, in order to surmount barriers to continuous monitoring of emissions, several countries base fees on inputs used or upon periodic spot checks combined with severe sanctions for violating emissions standards implied by the firms' fee payments. Finally, every country has fees set at realistic levels that are not (in themselves) likely to invite universal non-compliance that would render the system irrelevant.

3.3 Informal Regulation

As discussed in section 1, informal regulation refers to pressure exerted on polluters by private-sector groups such as community organizations, non-governmental organizations,

and trade unions. In this section, we briefly review evidence of informal regulation in six countries. Unfortunately, most of this evidence concerns water- rather than air-pollution.

3.3.1 Bangladesh

Formal regulation in Bangladesh is extremely weak due to severe shortages of funding and expertise. No formal written regulations, monitoring, or enforcement exists for water pollution. Huq and Wheeler (1993) reports on a 1992 survey of the abatement efforts of seven publicly owned fertilizer and wood pulp plants. The authors find that in two of three cases where community pressure was strong, plants undertook significant clean up efforts. Moreover, some plants negotiated agreements with local communities that involved the installation of abatement equipment and monetary compensation for damages to fisheries and paddy fields. In four cases where local pressure was not evident, only one plant undertook a significant clean up effort.

3.3.2 Indonesia

Informal regulation has also been studied in Indonesia. Pargal and Wheeler (1996) analyze data on releases of 'basic oxygen demand' (BOD) by a large sample of Indonesian factories in a variety of sectors from 1989 to 1990, a period when there was no effective national regulation for water pollution. The authors find that lower releases of BOD were significantly correlated with a set of variables that proxy for informal pressure including the per capita income, education, and population density of the community surrounding the firm, and the firm's share of total local manufacturing employment.

More structured state-backed informal regulation have also been effective in Indonesia. In the mold of EPA's 33/50 program, PROKASIH is a government sponsored but voluntary program. It was designed to clean up Indonesia's most heavily polluted waterways.[22] Beginning in 1989, firms were encouraged to sign letters of commitment to cut emissions by specific amounts in an agreed on time frame. In the program's first two and a half years, over one thousand firms signed such letters and most have taken at least some abatement measures as a result (O'Connor, 1994). To create incentives for compliance, the government has publicized firms' compliance records and has encouraged the media to do the same. According to Hettige et al. (1995a), the program "has elicited substantial pollution reduction from plants in 23 river basins. It has also apparently been taken by non-PROKASIH plants as a credible signal that the government is serious about combating industrial pollution" (5).

3.3.3 Mexico

In many Mexican cities, small-scale traditional brick kilns fired with debris like used tires and woodscrap, are a leading source of air pollution and a serious health hazard to residents of neighborhoods close to brickyards. Blackman and Bannister (1997 and 1998a)

[22] See Arora and Cason (1995) for a discussion of the 33/50 program.

report on efforts to introduce clean-burning propane into the brickyards of Cd. Juárez. They find that adoption of propane was correlated with community pressure applied by trade unions and community groups that supported, and in some cases enforced, regulations regarding the use of dirty fuels. Blackman and Bannister (1998b) reaches similar conclusions regarding efforts to promote the adoption clean fuels by brickmakers in three other Mexican cities.

3.3.4 Japan

Japan has a long tradition of formal/informal regulation (O'Connor, 1994). Beginning in the 1950s, prior to the promulgation of a national environmental policy, local citizens groups negotiated agreements with major local polluters. Such agreements are still common today. These agreements are not legally binding but local governments often exert some pressure to negotiate and comply. They remain popular for a number of reasons: they are seen by local officials as a means of achieving higher levels of environmental protection than officially mandated; legal and legislative costs are low; the agreements may address problems not covered by formal legislation; they improve the image of local business; and they may encourage the use of state-of-the-art technologies.

3.3.5 Conclusion

The above case studies illustrate that informal regulation can substitute for, or at least complement, formal regulation. They imply regulators have access to at least five means of promoting informal regulation: (1) state sponsored educational campaigns that help to make communities aware of the health risks created by pollution can raise the general level of concern over the emissions of local firms; (2) simple hortatory support (speeches and publicity) of environmental initiatives by government officials at the highest level possible can create incentives for local administrators, firms, and citizens to support informal initiatives; (3) authorities can work with and through local organizations such as trade unions and community organizations to promote low-cost voluntary initiatives; (4) government officials can make information about firms' emissions levels and abatement efforts publicly available to increase public pressure on polluters; and (5) the government can support formal/informal schemes like PROKASIH in Indonesia.

3.4 Summary

This section summarizes the findings of our review of international experiences with alternative instruments for regulating fixed point air pollution. In surveying OECD country experiences with EI policies we found that:

- Though EI mechanisms have received wide application in the last several decades, CAC still dominates.
- Few EI schemes have been intended to reduce emissions and of those that have, few have worked.

- EI's can have significant impacts on abatement, innovation, and abatement costs.
- EI's may not be appropriate for LDCs because:
  (a) emissions fee and permit systems (though not tax systems) are expensive to administer;
  (b) fees need to be set relatively high to have an impact and can therefore be expected to generate considerable resistance unless mechanisms are developed to lower compliance costs;
  (c) permit markets are constrained by imperfect information, uncertainty, high transactions costs, spatial differentiation of emissions sources, and market power, all characteristics of most developing countries.

In reviewing developing country experiences with EI policies we found that:

- Though fee systems are fairly common in developing countries, permit trading schemes are not.
- Fee systems have generally not had significant environmental impacts. The reasons are the same in almost every case: fees are set at a low level and are often eroded by inflation; monitoring and enforcement are weak; state owned enterprises with soft budget constraints are effectively exempted from the fees; and both distributional concerns and monitoring constraints prevent the inclusion of small, old, and/or economically fragile firms.
- Nevertheless, existing fee systems have at least two desirable characteristics: they open the door to a the establishment of an effective fee system and they raise much need revenue for environmental projects and programs.
- Practical innovations in traditional fee systems that may improve their suitability to developing countries include: returning some of the fees to the payees in a manner that reduces the cost of participating but keeps abatement incentives in place; exempting old and small firms with high abatement costs; two-tiered fee systems that lower abatement costs; taxing inputs such as the use of dirty fuels instead of emissions to lower monitoring costs; and maintaining fees at a realistic level to avoid universal non-compliance.

Finally, our brief review of informal regulation in developing countries suggested that:

- State sponsored educational campaigns that help to make communities aware of the health risks created by pollution can raise the general level of concern over the emissions of local firms.
- Simple hortatory support (speeches and publicity) of environmental initiates by government officials at the highest level possible can create incentives for local administrators, firms, and citizens to support informal initiatives.

- Authorities can work with and through local organizations such as trade unions and community organizations to promote low-cost voluntary initiatives.
- To increase public pressure on polluters, government officials can make information about firms' emissions levels and abatement efforts publicly available.
- The government can support formal/informal schemes like PROKASIH in Indonesia.

4. POLICY GUIDELINES

This section purports to draw upon the theory and evidence reviewed in sections 2 and 3 to develop broad policy guidelines. Ideally, such guidelines should be tailored to the specifics circumstances of each country (if not each municipality) -- obviously, certain approaches will be appropriate in circumstances but not in others. Yet, as detailed in the "Development and Environment," the 1992 World Bank Development Report, many developing countries share the following characteristics:

- serious fixed point urban air pollution problems
- lack of financial and technical resources for environmental protection
- weak regulatory institutions and weak complementary (judicial and legislative) institutions
- poor data collection and dissemination

Given this admittedly broad-brush characterization, it may be useful to offer a limited number of general policy prescriptions.

4.1 Designing Policies that Accommodate Institutional Weakness

As noted in section 2, in order for any type of regulation to be effective, the regulatory authority must be capable of establishing rules for the conduct for polluting sources, monitoring performance with respect to those rules, and enforcing compliance. Until such capabilities are established, the effectiveness of regulatory initiatives designed to control fixed source air pollution will be limited, no matter how well designed they are. There is not much that we, as economists, can contribute to mitigate these problems. The appropriate recommendations -- improving the technical training of personnel and bolstering financial and political support -- are both obvious and superficial. Our intent here is to offer recommendations on policy design.

Towards this end, two quick points regarding the implications of weak institutions on policy design are in order. First, rather than assuming that this problem will soon be resolved or assuming that it will never be resolved -- neither assumption is likely to be valid -- policy makers should design strategies that accommodate continued institutional weakness in the short to medium term. In sections 2 and 3 above, we describe a range of policies that place relatively limited demands on the ability of the regulator to monitor and enforce regulations -- so-called

"indirect instruments" such as taxes on inputs and technology standards. Second, we suggest that regulators promote strategies which incorporate EI instruments where practical, and which retain sufficient flexibility to allow for a movement towards EI instruments as monitoring and enforcement capabilities develop over time. We discuss our recommendations for such policies in more detail below.

4.2. Overcoming Data Constraints

Accurate data on emissions is needed to design, monitor compliance with and enforce environmental regulations. Again, the superficial solutions -- data collection initiatives, training, and analysis -- are both obvious and superficial. But here too it is worth repeating that policy design can and should work around constraints. Until reliable emissions inventory data and ambient air quality data become available, policy makers can rely on estimates of emissions derived by combining production data with "off-the-shelf" estimates of emissions by source. For several years, the World Bank has been developing data on emissions in developing countries using this methodology (see Hettige et al., 1995b).

4.3. Appropriate Economic Incentive Instruments

As discussed in section 3, EI policies that both resemble those described in theoretical texts and that have significant impacts on abatement are exceedingly rare, even in industrialized countries. Part of the reason is that such programs involve considerable administrative costs. Also, they demand a great deal from private actors who, in the case of fees, must not only pay to abate but must also pay fees on all emissions, and who, in the case of marketable permits, must bear considerable transactions and information costs. For these reasons, pure and effective EI instruments, especially marketable permit programs, are probably not practical for most developing countries.

Notwithstanding our recommendation regarding pure EI systems, as discussed in section 3, modified emissions fee systems probably *are* appropriate for many developing countries. Such system would have two principal benefits. First, they would provide the institutional and political foundation for a transition to an effective high-fee system -- i.e., a "foot in the door" -- that in time might enable regulators to avoid falling into the "inertia trap" that has made a transition from a CAC- to an EI-based regime difficult in developed countries. And second, they would raise much need revenue for environmental projects and programs.

The case studies in section 3 suggest a number of ways that such systems can be modified to head off objections that it places an unfair burden on industry, particularly small and old firms with high abatement costs. First, fees can be returned to the payees in a manner that reduces the cost of participating but keeps abatement incentives in place (for example, by basing the size of the rebate on the number of units of output produced). Second, old and small firms with high abatement costs can be exempted from the system altogether. And third, the fee system can be "two-tiered" so that firms pay a reduced fee on emission below a standard. As long as fees set below the standard are not negligible, some incentives to

innovate are retained. The fee system need not depend on continuous emissions monitoring. At least initially, it could be based on a "materials balance" approach, wherein fees are calculated according to the amount and type of fuels used, or upon periodic unannounced monitoring combined with severe sanctions for violating emissions standards implied by the firms' fee payments (as in China). Finally, fees should be indexed to inflation.

4.4 Indirect Instruments

As discussed in section one and in the first part of this section, indirect instruments, be they EI policies like taxes on dirty fuels or CAC policies like technology standards, may be a second best approach to pollution abatement in countries that have weak regulatory institutions. As the experience of many Central and Eastern European Countries illustrates, taxing and/or simply removing subsidies to dirty fossil fuels can have very significant impacts on air pollution.

For some industries where monitoring is especially costly, technology standards may be the only means of ensuring abatement activity. To the extent that technology standards are used, they should incorporate incentives for the use of clean technologies, not just end-of pipe measures. As discussed in section one, by combining technology standards with emissions fees, it is possible to mimic the effects of a emissions fee.

4.5 Informal Regulation

As discussed in section 3, informal regulation can substitute for, or at least complement, formal regulation. Regulatory authorities can promote informal regulation by the means listed in section 3.

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