Market-Based Instruments / Economic Incentives*

Introduction

This note provides guidance on the use of market-based instruments (MBIs) for pollution control. MBIs, by implementing an explicit or implicit price on emissions, create financial incentives for pollution control. These instruments use market signals to affect the behavior of both consumers and firms towards pollution. MBIs are also called economic incentives (EI) for pollution control and include pollution charges or levies, taxes, subsidies, and tradable permits.

Market-based instruments create incentives for firms to adopt low-cost technological or process innovations for pollution control. From a theoretical standpoint, "…if properly designed and implemented, market-based instruments allow any desired level of pollution clean-up to be realized at the lowest overall cost to society, by providing incentives for the greatest reductions in pollution by those firms that can achieve these reductions most cheaply" (Stavins 2003, 359).

Description and Application of Market-Based Instruments / Economic Incentives

Table 1 (adapted from Blackman and Harrington 2000) classifies pollution control instruments into two categories: direct and indirect. This classification compares major elements of MBIs with command and control (CAC) instruments. The use of direct instruments requires the regulator to monitor the emissions. MBI fees and levies can be grouped in one category, the charge system. Pollution charges are either fees or taxes applied as a proportion of the amount of pollution that a source generates. These are taxes levied on market activities that generate pollution or other negative spillover costs not covered in an item's price. Both an MBI charge system and an MBI tax system use financial instruments to persuade polluters to reduce pollution. In both systems, the regulator attempts to make pollution more costly to the polluter.

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Table 1. Classification of Instruments

Regulatory Tool	*Direct Instruments*	*Indirect Instruments*
Market-Based Instruments / Economic Incentives	Emission fees; Tradable permits	Taxes; Subsidies
Command and Control	Emissions standards	Technology standards

Emission Fees. Regulators may impose on polluters a direct charge for the emissions they produce. In an MBI charge system, the regulator sets up a standard for a pollutant, and a plant incurs a penalty when it exceeds the standard.

Tradable permits. Regulators may use tradable permits and create a market for pollution. In theory, they can achieve the same cost-minimizing allocation of the control burden as a charge system, while avoiding the problem of uncertain responses by firms (Stavins 2003). In a tradable permit system, an allowable overall level of pollution is established and subsequently allocated among firms in the form of permits. Firms that keep their emissions below their allocated level may then sell their surplus allotment to other firms or use them to offset excess emissions in other parts of their facilities (Stavins 2003). While the implementation of these tools has become widespread, there is no tendency towards replacing the basic regulatory approach with a purely economic one. "Economic instruments are complements mostly and substitutes only sometimes for other types of approaches" (OECD 1994, 187).

Taxes. Regulators may impose taxes which are similar to the direct emission fees, however taxes are indirect instruments. Because taxes do not require the regulator to determine an abatement level, they are easier to implement. Taxes seem appropriate in the context of fuel use and choice. Air pollution control has been addressed in policies aimed at discouraging the use of private transportation during peak hours. Evidence from Costa Rica showed that the choice between public and private transportation by commuters reflected the cost of transportation mode. Increases in cost per car trip affect transport substitution, although this effect seems small. Increases in other costs such as parking do not seem to be as effective as expected. In 1990, a USAID study estimated that by age seven, Bangkok children collectively suffered a loss of up to 700,000 IQ points as a result of elevated blood-lead levels (O'Connor 1999). This research prompted the Thai Government to introduce unleaded petrol at a slight discount relative to leaded petrol, subsidizing the former through a surtax on the latter (O'Connor 1999). Moreover, the Thai Government introduced a regulation in 1993 requiring all cars sold in Thailand from that date forward to be equipped with a catalytic converter; these measures resulted in the market share of unleaded petrol rising to almost 50% in the following few years (O'Connor 1999).

There is evidence from Santiago, Chile, that consumers responded to changes in relative prices by switching to lower-priced natural gas (Coria 2009). This supports the use of taxes on non-clean fuels. Even if such taxes do not create incentives to abate emissions per se, they might create incentives to use

Box 1. Are Fuel Taxes Regressive?

A major concern about fuel taxes is their possibly regressive nature, and whether they should therefore be opposed on distributional grounds. Household survey data from Costa Rica was used to study the effects of a fuel tax; it was found that a 10% fuel price hike through all types of direct and indirect spending would be slightly regressive, but that the magnitude of this combined effect would be modest (Alpizar and Carlsson 2003). The study concluded that distributional concerns need not rule out using fuel taxes to address pressing public health and safety problems, particularly if gasoline and diesel taxes can be differentiated.

cleaner fuels and reduce emissions. This approach also provides for ease of administration, because collection of revenues would be implemented via tax collection institutions (Blackman and Harrington 2000). Moreover, consumption of fuel is usually much easier to monitor than emissions. Taxes generate revenues for governments. These revenues can be used to fund investment in projects. Nevertheless, taxes can be politically difficult to put in place. Taxes need to be high enough to create a disincentive that then translates into environmental benefits. Moreover, it is possible that the taxes will be regressive, hence particularly affecting the poorer part of the population. Decision makers may find this unappealing. The issue of potential regressivity of fuel taxes is addressed in box 1. Furthermore, the successful implementation of taxes needs proper enforcement. An example is the forestry tax in Brazil and Colombia, a tax charged for wood consumption when the harvesting is not compensated for by reforestation activities. This may be seen as an incentive to curb deforestation. Its enforcement, however, has been very weak. Therefore the tax did not seem to affect the deforestation rates nor provide important budgetary benefits (Seroa da Motta and others 1999).

Subsidies. Regulators may impose subsidies to induce reductions in pollution. Among the subsidies that may be used to help manage environmental pollution are grants, low-interest loans, favorable tax treatment, and preferential procurement policies for products believed to pose relatively low environmental risks. Subsidies for environmental management are, however, sometimes criticized because they can be viewed as a prize given to polluters. Thus, such subsidies may be seen as helping to bear costs that should be the polluters' responsibility. Subsidies for resource input have been successfully implemented in Latin America. Reforestation subsidies, for instance, have been an important driver behind Chile's forestry sector expansion, while energy subsidies in Barbados and Ecuador seem to have expanded the use of cleaner substitutes (Seroa da Motta and others 1999).

Other environmentally related subsidies, such as federal support for timber harvesting in national forests, are criticized because they have proven harmful to the environment (Seroa da Motta 2006). Nonetheless, subsidies have become a fairly common tool to manage the environment at every level of government. Eliminating environmentally harmful subsidies can be even more effective when used to improve environmental quality. In the early 1990s, the World Bank made the phase out of pesticide subsidies a condition for new lending to Egypt. As a result, pesticide use dropped by nearly 70% over the next five years (Anderson 2002).

One possible circumstance in which subsidies can be justified is the dissemination of new technology. Subsidies to a few early adopters of a technology that is virtually unknown in a particular region or country can help demonstrate the profitability and pollution-reduction effectiveness of a technology so that others adopt it later. These early adopters are thus compensated for taking a risk (Peszko 2005). The amount of compensation and the identification of the individuals are very important and add an extra element of difficulty in the implementation of this tool.

Deposit-refund systems. Regulators may require a monetary deposit at the time a product is sold. The deposit is eventually refunded when the item is returned. This scheme has been implemented successfully in many high-income countries. In the United States, deposit-refund systems have been applied to control the disposal of lead-acid batteries and products containing aluminum, as well as glass, pesticide containers, and tires. The private sector often creates and manages a disposal system. This system helps subsidize the return of recyclable products. Deposit-refund systems thus appear to be appropriate instruments for discrete, solid commodities. Such systems may, however, have a high cost of implementation. For instance, collecting and refunding deposits on the sale of individual products and product disposal can be expensive activities. Among middle-income countries, South Korea has one of the most exhaustive deposit systems, covering a multitude of products from packaged paper, to televisions, to washing machines.

Prerequisite Factors for Marked-Based Instruments / Economic Incentives

Strong regulatory and enforcement mechanisms, and strong institutions, are required for MBIs to function effectively. MBIs may need to be preceded by, and accompanied by, CAC actions. There are three essential phases that need to be considered by institutions or regulators in developing countries: first setting up the rules; second monitoring performance and third enforcing compliance. The achievement of these three phases can be affected by a host of problems. First of all the issues of priority in the agenda. Environment and development may be seen as substitute rather than complements and in a developing country context environmental quality can be seen as something that can be sacrificed for development. Moreover, regulatory institutions can be weak, understaffed and with lack of resources. This can impair both monitoring and enforcement phase. Finally, developing countries often have a large set of very small firms that are more difficult to monitor. Firms location may also be very spatially disperse. Besides these points, when one evaluates the implementation of MBIs in a developing country a set of issues should be considered. These issues can be represented in the figure below, and all these element add difficulties in the implementation of monitoring and enforcement:

Advantages and Limitations of Market-Based Instruments / Economic Incentives

The benefits of MBIs include flexibility and efficiency, especially since two of the most important dimensions of environmental regulations are monitoring and enforcement. In practice, MBIs are used together with command and control (CAC) instruments, which set performance targets and specify the technology to be used. Each of the various types of MBI has its own characteristics, strengths, and weaknesses (see table 2, next page).

Figure 1. The Environmental Regulatory process

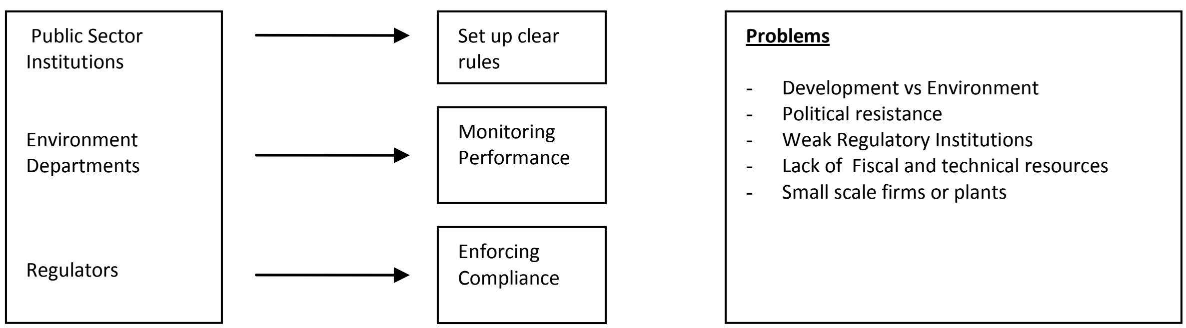

Table 2. Success Matrix for Implementation of MBIs

MBIs	*Activities and requirements to establish and implement the instrument*	*Conditions for success*	*Strengths*	*Weaknesses*
Charge system	The regulator needs to: • Set up clear rules • Collect the revenue	• Monitoring data on pollutant must be available • Enforcing compliance • Institutional integrity must be very high	• Charges proportional to pollution	• More complex to coordinate with different sources of pollution • Monitoring and enforcement are costly
Deposit refund	The regulator needs to: • Set up clear rules • Collect the revenue	• Front-end charge (deposit) combined with refund payable when quantities are turned in for recycling. • Participation by households	• Low legal, institutional, and political barriers • No need for monitoring when voluntary	• Difficult to enforce because of the voluntary nature of the scheme • High cost of implementation
Taxes	The regulator needs to: • Set up clear rules • Collect the revenue	• Enforcing compliance • Institutional integrity must be very high	• Multiple sources of pollution • No need to identify an abatement level • Works even when monitoring data unavailable • Easy to manage • Generate revenues	• Do not always incentivize adoption of abatement technologies • May affect non-targeted activities • Politically difficult to accept • Distributional impacts can be distortive
Subsidies	• The regulator needs to set up clear rules	• Monitoring data on pollutant must be available • Enforcing compliance	• Incentive to actually change system	• Taxpayer gets part of the pollution burden
Tradable permits	• The regulator needs to set up clear rules	• Data needed for initial allocation • Tracking system required • Enforcing compliance	• Flexibility in their application • Cost savings for the regulator • Less efficient units of production are likely to stop operating	• Major regulatory requirements • Consistent legal framework • Political resistance

A number of points can be highlighted:

- There is evidence that MBI pollution charges and fees curb air and water pollution.
- These results seem to be stronger for larger units of production.
- Taxes can reduce air pollution by providing incentives for switching to cleaner energy.
- A balanced mix of regulatory measures and MBIs will effectively achieve pollution reduction targets. A prime example is the implementation of tradable permits.
- MBI requires effective systems and institutions for monitoring, and for command and control.
- CAC (through setting up standards) can be superior to MBI in some situations.
- CAC approaches may be a sensible initial approach, especially when there is limited information and environmental damage is an important issue.
- Monitoring and enforcement are very important; without both, policies have been ineffective.

Interaction with other Tools and Possible Substitutes

Command and Control (CAC) instruments are often contrasted to MBIs. By setting up standards, a CAC action can be superior to MBI in some situations. While setting performance standards through CAC can reduce some of the overall pollution, this process neglects consideration of the possible costs of holding all firms to the same target, since this can be expensive and counterproductive (Stavins 2003). A central issue to be considered is the cost effectiveness of pollution control instruments, and CAC instruments seem to impose a relatively high cost on firms (Pandey 2005).

It would be inaccurate to view CAC and MBIs as mutually exclusive or opposing approaches since, in many circumstances, these tools are complementary. Moreover, the success of MBIs depends upon an effectively functioning system for monitoring, and for command and control, including properly functioning institutions. CAC may be a sensible initial approach and be followed by MBIs. Therefore in reality CAC and MBIs can and do operate together. For example, regulators might establish a specific threshold level (a standard) of pollution, which is a CAC action, and apply a fee for the amount of pollution above that threshold, which is an MBI action.

Much recent attention has been devoted to informal, voluntary, or informational polices, all of which are complementary tools to both MBIs and CAC. The usefulness of those policies becomes clear when one considers the issues of monitoring and enforcement. The potential beneficial effect of these policies for pollution control was highlighted by the World Bank (Blackman 2009a, 2). Evidence drawn from three empirical studies of plant-level abatement practices conducted 1992–94 clearly stressed that environmental performance is strongly and positively related to external sources of pressure and community action (Blackman and Bannister 1998; Dasgupta and others 2000).

Enforcement and compliance play very important roles in environmental performance. In China, inspections dominate and better explain the environmental performance of industrial polluters. Public disclosure mechanisms in developing countries may be a useful model to consider given limited government enforcement resources. Public disclosure can affect firms' responsiveness to industrial pollution control, as has been demonstrated in Indonesia. The role of the press has been analyzed in India. It offers a test of the hypothesis that the press can act as an informal agent of pollution control. This hypothesis was tested using monthly water pollution data from four hot spots in the state of Gujarat, India, for the period 1996 to 2000.

The study's results show that the press can function as an informal regulator if there is sustained interest in news about pollution. The role of capital markets appears relevant as well. Evidence from capital markets in Argentina, Chile, Mexico, and the Philippines shows that they react to announcements of environmental events, such as those of superior environmental performance or citizens' complaints. An empirical analysis of the impact of traditional enforcement and information strategies provided insights into the relative impact of traditional (fines and penalties) and emerging (public disclosure) enforcement strategies (Foulon and others 2002). Public disclosure of environmental performance creates additional and strong incentives for pollution control.

Practical Examples of Market-Based Instruments / Economic Incentives and Lessons Learned

Theoretical and anecdotal information on MBIs in developing countries is fairly extensive; however, evidence based on robust econometric analysis is limited (see table 3).

Table 3. Applications of MBIs in Developing Countries*

MBIs	*Issue or Source of Pollution*	*Application in Developing Countries*	
Charge system	• Industrial air and water pollution from large units	• **China** • Colombia • Ecuador	• Malaysia • Mexico • Philippines
Deposit refund	• Waste management households (glass and plastic, car batteries)	• Colombia • Ecuador • Jamaica • Korea	• Mexico • Sri Lanka • Taiwan • Venezuela
Taxes	• Air pollution mostly from large units • Fuel use • Traffic congestion • Halting deforestation via a "forestry tax"	• Brazil • **Chile** • Kenya	• Mexico • Thailand
Subsidies	• Air pollution from both large and small units • Used to incentivize reforestation and adoption of cleaner technologies	• **Brazil** • **Chile** • Colombia • Ecuador	• Kenya • Mexico • Tanzania
Tradable permits	• Air pollution (SO_2) from large units • Water use by large units • Car use/congestion in megacities	• Chile • Mexico • Singapore	

* ***Bolded items signify that evidence is based on quantitative studies***.

The Chinese pollution levy system is one of the most comprehensive emission charge system in the developing world (see box 2). Data on water found that China's levy system had been working much better than previously thought (Wang and Wheeler 1996). The results suggest that pollution discharge intensities have been highly responsive to that pollution intensity has been responsive to this instrument. A variety of analyses at both provincial and plant levels estimated responsiveness of pollution to the levies for different pollutants.

Box 2. Chinese Levy System

In 1982, China's State Council began nationwide implementation of pollution charges. The system is applied to hundreds of thousands of sources of air, water, solid waste, and noise pollution. The implementation has been very widespread, and year after year the number of firms participating and the revenues collected have increased. For wastewater, fees are calculated for each pollutant in a discharge stream and the polluter pays the fee associated with the highest value among all the pollutants (Wang 2002). The resources collected as levies are used to finance environmental institutional development, administration, and environmental projects, and to provide subsidies or loans to firm-level pollution control projects. Enforcement is implemented via a schedule of penalties.

For air pollution, the results imply that emissions decline by about 0.65% for each 1% increase in the effective levy rate. Water pollution declines by 1.08% for each 1% increase in the levy. For SO_2 emissions alone, the estimated decline is again noticeable, 1.03% for each 1% increase in the levy. Firms' response to the water pollution levy is focused on process change, rather than end-of-pipe removal.

A similar water pollution scheme was adopted in Colombia. The Colombia discharge fee program encountered a set of serious problems that limited its success in some regions. These included widespread noncompliance by municipal sewerage authorities, and a confused relationship between discharge fees and emissions standards. Nonetheless, Colombia's program seems to have achieved its targets. In some watersheds, pollution loads dropped significantly after the program was introduced (Blackman 2009b). For instance, in the ecologically sensitive area of Rio Negro, watershed water pollution from industrial sources was reduced by 28% (Sterner 2003).

In Poland, a revenue-raising charge to provide funds for environmental protection and water management on a national, provincial, and municipal scale was implemented. Pollutants targeted include biochemical oxygen demand (BOD) and chemical oxygen demand (two indicators of the physico-chemical properties of water samples), suspended solids, chloride and sulphate ions, heavy metals, and volatile compounds. In 1996 BOD decreased by 11,000 tons and insoluble substances by 71,000 tons (OECD 1999). Similar actions were taken in Estonia, Latvia (Speck and others 2006), Malaysia, and the Philippines (World Bank 1997). Box 3 presents information about MBIs in developed countries.

Box 3. MBIs in Developed Countries

During the last 20 years many OECD countries have experimented with MBIs for pollution control. Charges and fees are the most popular tools (both emissions and product charges). For instance emissions charges levied on air and water pollutants have been applied in more than 20 countries. Carbon taxes in Denmark, Norway, and Sweden are intended to have an incentive effect, in addition to a revenue-generating effect, but it has been difficult to determine their actual impacts (Blackman and Harrington 2000). Claims have been made that the Swedish and Norwegian taxes have reduced carbon emission (Larsen and Nesbakken 1997). Stronger evidence is on reduction in water pollution. The Netherlands, for instance, has assessed effluent fees on heavy metals discharges from large enterprises, and organic discharges from urban and farm households, and from small, medium, and large enterprises. In some cases, the charges reduced total organic discharges by half, and industrial organic emissions by 75 percent (World Bank 2000). The most ambitious implementation of MBIs has been the control of sulfur dioxide (SO_2) Polluters were allowed to trade the permits or bank them. The results of the program were very good. Target emissions reductions were achieved (Stavins 2003).

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APPENDIX

Details of Studies proposing quantitative evidence

MBIs	*Study*	*Country*	*Issue*	*Key Findings*
Charge system	**Wang and Wheeler 1996**	**China**	Water pollution	Industry highly responsive to the levy
	Wang and Wheeler 1999		Air and water pollution (TSP COD)	Levy decomposition into two components: pollution intensity of process production and degree of end-of-pipe (EOP) abatement
	Wang 2002		Water Pollution (COD)	Expenditures on end-of-pipe wastewater treatment are strongly responsive to the pollution charges
	Wang and Wheeler 2005		Air and water pollution (COD TSS SO2)	Strong marginal deterrence effect for the pollution levy
Subsidies	**Seroa da Motta 2006**	**Brazil**	Determinant of Environmental Performance	Market incentives are also very influential determinants. Cost savings on inputs and subsidized credit are found equally important
	Coria 2009	**Costa Rica**	Fuel expenditure	Large response of the rate of switching to the lower price of natural gas
Taxes	**Alpizar and Carlsson 2003**	**Costa Rica**	Transport Mode	Fuel taxes can also be useful to incentivize technological change and adopt alternative technologies