URBAN ENVIRONMENTAL PROBLEMS:
THE ROLE FOR ECONOMIC INSTRUMENTS

Peter Kennedy

University of Victoria

Elayne Yee

Malaysian Institute of Economic Research

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ABSTRACT

This report assesses the role that economic instruments can play in helping Malaysia to achieve effective and efficient policy for dealing with urban environmental problems. It focuses on three areas in particular: urban air pollution, urban water pollution, and solid waste management. In each area we describe the type of instruments that can be applied, design principles for their application, and potential limitations to their use in practice.

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1. INTRODUCTION

Malaysia has experienced rapid economic growth over the past twenty years, and despite the current downturn, the economy is likely to continue to grow rapidly over the medium term. If managed well, that growth will bring substantial improvements in living standards without an excessive adverse impact on environmental quality. However, if managed badly, continual growth in material consumption and resource use will cause serious long term damage to the environment, and eventually undermine its productive capacity. This will in turn have significant adverse impacts on the potential for further economic development. The policy challenge for Malaysia is to develop and grow at a rate and in a manner that is sustainable.

In many ways, Malaysia has already had considerable success in rising to that challenge. Investments in urban public transportation, the progressive elimination of lead from gasoline, the clean-up of the palm oil industry, and the recent rationalization of waste management policy represent some of the highlights of that success. However, there is much work left to be done. The persistent haze over Kuala Lumpur is perhaps the most visible testament to that fact. In pursuing policy successes on this and other environmental fronts, the key watchword is balance; the benefits of unfettered growth in economic activity must be weighed carefully against the costs of environmental damage.

The task of achieving an optimal balance between economic activity and environmental protection is a difficult one, and one that is complicated further by the risk of irreversibility. The optimal level of ambient environmental quality in Malaysia today is, to a large degree, a function of current economic wealth. The environmental standards that are appropriate today are higher than they were twenty years ago because the country is now much wealthier. Similarly, appropriate environmental standards in 2020 will be higher than what is appropriate today. However, the environmental standards set today have both immediate and long term consequences, and some of those long term consequences may be irreversible, or reversible only at considerable cost. Species extinction is perhaps the most obvious instance of irreversibility; another is the buildup of carbon dioxide in the global atmosphere, which is effectively irreversible given current technology. Similarly, the accumulation of heavy metals in river sludge is reversible only at massive cost. While these environmental impacts may be partly tolerable today based on current wealth levels, the associated depletion of natural capital may be heavily regretted in the future. Current environmental policy must be cognizant of that fact.

This does not mean that current Malaysian environmental standards should be set at levels that are inappropriately high given its current wealth. However, it does mean that current environmental policy design must be based on the recognition that the Malaysia of the future will be wealthier and will demand higher environmental quality than the Malaysia of today, and that current environmental policy will leave an indelible mark on the environment of the future. Setting higher environmental standards today is an investment in environmental quality and economic development for the future.

Of course, the imposition of strict environmental standards does not come without cost. There is an inevitable tradeoff between various forms of current consumption (for example, the convenience of driving versus high ambient air quality), and between current consumption and investment for the future, including investment in natural capital. While the cost of environmental standards may not be as high as their detractors often portray, it is unrealistic to think that higher environmental quality is free. There is a real short run cost to higher environmental quality and optimal standards must be based on a balanced assessment of the associated costs and benefits. In the current economic climate there may be pressure to shift that balance against environmental quality. This would be a mistake; while being cognizant of the current slowdown, environmental policy formulation must remain far-sighted.

At the same time, it is crucial that now more than ever, the cost of achieving high environmental standards be no higher than necessary. The best way to ensure this is through the judicious choice of regulatory instruments. In particular, now may be an opportune time for an expansion in the use of economic instruments for pollution control. There is considerable scope for greater use of economic instruments in Malaysia, with the potential for substantial economic efficiency gains. The purpose of this paper is to highlight some of the areas where economic instruments could be employed in Malaysia, to the mutual benefit of the environment and the economy.

While economic instruments are potentially applicable to some degree in all areas of environmental policy, the paper focuses on their application to urban pollution control.

Like much of South East Asia, Malaysia has experienced extremely high rates of urbanization in recent years, and existing urban infrastructure is becoming stressed under the burden, especially in Kuala Lumpur. The high concentration of people and industry in urban areas also puts considerable stress on the assimilative capacity of the environment in those areas. The consequences are air and water pollution, and large volumes of solid waste for which there are very limited disposal options. Moreover, the concentration of people in urban areas means that large numbers of people are exposed to airborne and waterborne pollutants, thereby raising the human cost of that pollution.

At the same time, urban areas have been the engines of recent economic growth and their importance is likely to grow even more in the medium term. It is therefore crucial that policies to address urban pollution problems do not unduly stifle the productivity of those areas. Economic instruments have considerable potential to implement a balanced approach to urban environmental management in a cost-effective manner. The purpose of this paper is to highlight the role that economic instruments can play, and to promote their use in the urban Malaysian context.

The rest of this report is organized as follows. Chapter 2 provides an overview of economic instruments for pollution control, and their key advantages and limitations. Chapters 3 to 5 then examine potential applications of economic instruments in three broad areas: urban air pollution, urban water pollution, and solid waste (hazardous and non-hazardous). Chapter 6 concludes with some summary recommendations.

2. ECONOMIC INSTRUMENTS FOR POLLUTION CONTROL: AN OVERVIEW

This chapter describes the main types of economic instruments for pollution control, and outlines design principles for their applications, and practical limitations to their use.

2.1 Principles of Environmental Policy Design

Markets allocate resources on the basis of private costs and benefits to the economic agents involved. However, many of the actions taken by private agents, such as the production and consumption activities of firms and consumers, have associated costs and benefits that the agents themselves do not incur. For example, when a motorist drives her car on the streets of Kuala Lumpur, she imposes congestion costs on other drivers, and air and noise pollution costs on residents. Economists refer to these external costs and benefits as *externalities*, since they are external to the agent taking the action. Externalities can cause private costs and benefits to differ from true social costs and benefits, and thereby lead to a misallocation of resources.

The *social cost* of a particular action comprises the private cost to the agent plus any external cost of the action; similarly, the *social benefit* comprises the private benefit plus any external benefit. It is these social costs and benefits, rather than private costs and benefits, that are important for efficiency in resource allocation. In particular, *economic efficiency* requires that an action be taken if and only if the associated social benefit outweighs the associated social cost. Since externalities cause social costs and benefits to differ from private costs and benefits, actions based purely on private costs and benefits do not necessarily lead to efficient outcomes.

Environmental problems, and many other resource allocation problems, can be viewed in precisely these terms. For example, the negative externalities associated with vehicle use mean that too many people choose to drive; individual decisions based on private costs and benefits lead to higher traffic volumes, and higher levels of the associated costs, than is dictated by an optimal balance of social costs and benefits. All environmental problems can be framed in the same basic terms. Thus, free market actions tend to produce too much pollution, too few national parks, too little protection for biodiversity, poor logging practices, over-fishing, and so on. The use of environmental resources therefore requires careful regulation.

2.1.1 Command-and-Control vs. Pricing

One possible solution to the problem of externalities is for the government to place direct restrictions on individual actions, and thereby try to implement an efficient outcome through direct centralized control. In the context of environmental policy, this approach is called *command-and-control regulation*. This is still the dominant form of environmental policy in Malaysia and most other countries. It is typically applied through the imposition of environmental standards on the technologies and performances of individual firms and products, enforced through the threat of penalties for non-compliance.

Command-and-control regulation can be very effective in many circumstances, and there will always remain a role for some elements of this approach in any well-designed environmental policy framework. However, command-and-control regulation has a number of important limitations and shortcomings (upon which we elaborate below), and in many circumstances there exists a better alternative: *internalization of externalities through pricing*. The basic idea behind pricing is to allow individual agents the freedom to make choices but to ensure that those choices take account of the external costs and benefits of their actions; this is achieved by attaching a price to those externalities. Thus, an agent pays a price for any external cost she imposes on others, and receives a price for any external benefit she bestows on others. In this way, the formerly external costs and benefits are *internalized* into the agent's private decision-making. If the prices are set correctly, then the corrected private costs and benefits will coincide with the true social costs and benefits, and private actions will thereby produce efficient outcomes without the need for direct government control over those actions at an individual level.

2.1.2 Alternative Approaches to Pricing Externalities

It is useful to think of the various approaches to pricing externalities in terms of a continuum over degrees of privatization. At one extreme is complete privatization, whereby the government simply assigns explicit private property rights over the resources involved, and leaves the market to determine prices without further government intervention. This is sometimes called the "Coasian bargaining approach". The only role for government under this approach is to assign and enforce property rights. This approach to allocating resources underlies many market transactions, and there is possibly some scope for its application to the allocation of environmental resources. In particular, fisheries, forestry, biodiversity and water supply are some areas where complete privatization may yield good results under some circumstances.

However, most environmental problems are not amenable to complete privatization, because the assignment and enforcement of private property rights is neither feasible nor politically acceptable. For example, assigning complete private ownership of the atmosphere, and allowing individual motorists and other polluters to bargain with the owners of the atmosphere over the price to be paid for air pollution, is not a workable solution to most air quality problems.

Less extreme approaches to pricing externalities involve varying degrees of privatization and ongoing government intervention. For example, the government may partially privatize a fishery or forest by assigning ownership rights to private individuals but at the same time place restrictions on trade and exploitation of the resource. Similarly, traditional public utilities, such as those that provide water, electricity, garbage collection, wastewater treatment, and so on, may be privatized but remain regulated with respect to their pricing and supply policies.

Economic instruments provide a mechanism for the government to intervene in the pricing of externalities while at the same time allowing the allocation of resources through private actions. The key feature of economic instruments is that they assign an explicit price to the use of environmental resources, and that price is controlled either directly (as with environmental charges) or indirectly (as with tradeable emission permits) by the government. [1]

[1] Confusingly, some commentators include penalties for the violation of command-and-control type standards as a type of economic instrument. This is misleading because while penalties for non-compliance

There are a wide variety of economic instruments available to policy-makers, and the appropriateness of each depends on the particular policy context. (A taxonomy is given in section 2.3 below). Different types of economic instruments differ in the mechanism by which they set a price on environmental resources, but in all cases the objective is to ensure that the price paid by the user is truly reflective of the social cost of the resource.

2.1.3 The "Polluter Pays Principle"

It is important to distinguish between the use of economic instruments and the adoption of the "polluter pays principle". All economic instruments assign a price to pollution but they differ in the degree to which polluters are required to pay that price. For example, a pollution fee requires that the polluter pays a price for each unit of pollution generated. In contrast, an abatement subsidy is a payment to the polluter for each unit of pollution reduction measured against some specified baseline. Both instruments ensure that polluters incur an opportunity cost when they pollute, and this creates an incentive for those polluters to take that pollution into account when making decisions. However, the two instruments differ markedly in terms of the implicit assignment of property rights over environmental resources. Paying a polluter not pollute (by subsidizing pollution abatement) implicitly assigns the right to pollute to the polluter. In contrast, levying a tax on pollution implicitly assigns property rights to the state; polluters are implicitly deemed to have no right to pollute and must pay for the privilege. This latter assignment of property rights is generally referred to as the "polluter pays principle".

The "polluter pays principle" has been widely adopted around the world. There are three main reasons for this. First, requiring polluters to pay for their use of environmental resources is usually more acceptable politically than implicitly assigning polluters the right to pollute.

Second, subsidizing abatement requires the expenditure of costly public funds, while taxing pollution generates revenue which can potentially reduce the need to

create implicit prices (or "shadow prices") for pollution, these implicit prices have discontinuous properties, and very different incentive effects from those created by explicit pricing. We return to this point in section 2.2.

generate revenue from other distorting taxes. This is discussed further in section 2.2.3 below.

Third, paying polluters not to pollute raises the problematic issue of identifying the polluters. Every firm and every individual is a potential polluter, and paying agents not to pollute creates an incentive for potential polluters to become actual polluters, and then demand a subsidy for not polluting. Thus, the payment of pollution abatement subsidies has the potential to *raise* the level of pollution in aggregate. In practice, this problem is typically dealt with by placing restrictions on who is eligible to receive pollution abatement subsidies, through some kind of “grandfathering” scheme that assigns pollution rights according to historical pollution outputs. Nonetheless, if not designed carefully, abatement subsidies have the potential to generate perverse effects, or at least prove less effective than anticipated. We discuss subsidies at greater length in section 2.3.

2.2 Advantages of Economic Instruments

Economic instruments have a number of potential advantages over command-and-control regulation. The most important of these are:

- cost-effective implementation of pollution targets
- the creation of ongoing incentives for pollution abatement and technological change
- the potential for revenue generation.

2.2.1 Cost-Effectiveness

Economic efficiency requires the balancing of costs and benefits in the use of environmental resources. However, making an accurate assessment of social costs and benefits with respect to environmental resource allocations is often difficult. In practice, many environmental policies must be put in place with little or no information about the associated social costs and benefits. This generally means that policy is formulated as a set of environmental quality targets, determined through a process of lobbying, counter-lobbying, and consultation.

The role for economic analysis in this policy setting is twofold. First, there needs to be an ongoing effort to value correctly the social costs and benefits of particular environmental quality targets with a view to revising those targets towards efficiency. Second, policy instruments must be designed to achieve *cost-effective* implementation of targets; that is, targets must be met at the lowest possible cost. The importance of cost-effectiveness cannot be overstated. Poorly implemented environmental targets can impose unnecessary costs on industry and individuals, thereby undermining productivity and competitiveness, and wasting valuable resources that could otherwise be devoted to achieving higher living standards, both materially and in terms of improved environmental quality.

Cost-effective pollution reduction requires that the largest share of pollution abatement (that is, pollution reduction) be undertaken by those sources with the lowest cost of abatement.[2] For example, consider a policy target of reducing emissions of suspended particulates from industrial activity in a particular region. Some polluting firms may belong to vibrant, expanding industries while others may belong to stagnant or contracting industries. In such circumstances the cost of cutting emissions is likely to be higher for firms in expanding industries since for these firms there is a greater opportunity cost of cutting output or devoting productive resources to pollution control. A cost-effective implementation of the pollution reduction target would allow these high abatement cost firms to contribute less to achieving the target than firms with lower abatement costs.

This cost-effective solution generally cannot be achieved through *uniform standards* that require all firms to undertake the same level of abatement, or set the same maximum allowable emission levels for all firms. Such a policy cannot achieve least-cost implementation of the aggregate abatement target unless all firms happen to have the same abatement cost structure, and this is highly unlikely.

In contrast, a policy that puts an explicit price on pollution and allows firms to choose their own level of pollution in response to that price can in principle achieve a pollution target at least cost. This outcome is achieved in the following way. Each firm makes its own assessment of its cost of abatement and compares that with the cost of *not* abating; that is, the price to be paid for polluting (either an explicit price or as a foregone

[2] The technical condition for cost-effectiveness, under plausible assumptions about the nature of abatement cost functions, is that *marginal abatement costs* must be equated across pollution sources.

subsidy). A profit-maximizing firm will cut its pollution up to the point where the cost of cutting further is just equal to the cost of emitting; beyond that point it is more profitable for the firm to pay the price for polluting. This means that when all firms face the same price on pollution, high abatement cost firms will cut pollution by a smaller amount than low abatement cost firms. Thus, a cost-effective solution is achieved.[3]

In principle, this cost-effective solution could be achieved in a centralized manner under a command-and-control approach. In particular, the regulator would assign different standards across firms in a way that ensures that high abatement cost firms are allowed to emit more than low abatement cost firms. The problem in practice with this approach is that the regulator usually cannot observe the abatement costs of individual firms. That is, the problem is one of limited information. This is precisely the same problem that planned economies face when trying to decide where to allocate resources; the planners have very little information about demand and supply conditions in the various sectors. The solution to that problem is to allow markets to allocate resources. In a market, prices convey information to buyers and sellers and ensure (under ideal conditions) that resources are directed to their most valuable uses. The same logic underlies the use of pollution; the information problem for the regulator is circumvented by allowing the price mechanism to allocate pollution across sources according to relative abatement costs.

2.2.2 Incentives for Cleaner Technology Adoption

The key to long term sustainable development unquestionably lies in technological change. The limited assimilative capacity of the environment means that there are finite limits to the amount of physical material that can be cycled through the system without causing it to breakdown. Thus, a reliance on an ever-increasing consumption of materials to support growth in living standards simply cannot be sustained. This does not mean that growth in living standards is necessarily limited, but it does mean that growth must rely

[3] Formally, each firm cuts pollution to the point where its marginal abatement cost is just equated to the price on pollution . Since each firm behaves in this way, and since each firm faces the same price on pollution, these individual actions bring into equality marginal abatement costs across firms, as required for cost-effectiveness.

increasingly on finding new and better ways of exploiting finite physical resources to provide consumption.

The importance of technological change demands the use of policies that foster it, and therein lies the most important advantage of economic instruments over other policies. Assigning an explicit price to pollution creates a powerful ongoing incentive for pollution sources to find alternative products and production techniques that are less polluting. In contrast, command-and-control type standards create incentives for cleaner technology adoption only up to the point where the standard imposed is no longer a binding constraint on profitability. Beyond this point the firm faces a zero implicit price on pollution and has no incentive to reduce pollution further. However, all pollution imposes a social cost and therefore there is always some social benefit from finding ways to reduce pollution below the level of the standard. That social benefit is not reflected in the private incentives of the firm when facing a fixed standard. In contrast, assigning an explicit price to every unit of pollution can internalize that social benefit and thereby create the right incentives for technological change.

Of course, whether or not the social benefit from technological change is correctly reflected in private incentives under pollution pricing depends crucially on the level at which the price is set. Too low a price will create too weak an incentive while too high a price will create too strong an incentive. This is an important point that is often misunderstood. In particular, it is often assumed that all technological change that leads to lower levels of pollution is necessarily worthwhile. This is false. Technological change is itself costly and should only be made when the expected benefits outweigh the costs; to do otherwise means that valuable resources are being diverted away from some other activity, including technological change in other sectors, that would yield greater net benefits to society. Thus, it is equally important that technological change in any given sector not be too rapid as it is that technological change not be too slow. The key to ensuring that the right degree of technological change is undertaken in response to pollution pricing is to set the price on pollution correctly; section 2.3 discusses some guiding principles for setting that price.

2.2.3 Revenue Generation

The pricing of pollution can potentially raise revenue for the government. While this can be an important side-benefit, it must be stressed that the primary purpose of economic instruments is *not* to raise revenue; their primary purpose is to change incentives in favour of more efficient resource use.

Nonetheless, the possibility of using “green taxes” and other price-based instruments in place of more traditional forms of taxation has generated considerable discussion on the so-called “double dividend” from economic instruments. This “double dividend” comprises the direct efficiency gains on the environmental side plus the potential efficiency gains from reducing other forms of taxation, such as income taxation and corporate taxation, which distort incentives to work and invest.

While this “double dividend” may exist in principle, and while government revenue should generally be directed to its most valuable use, an important cautionary point must be made. Any substitution away from traditional taxes towards “green taxes” necessarily creates a reliance on these green taxes as a source of revenue. Such a reliance has the potential to compromise the integrity of environmental policy formulation. One way of avoiding the problem of reliance on revenue from green taxes, and at the same time foster political support for such taxes, is to earmark the revenue for funding environmental projects. This funding can take the form of publicly funded environmental rehabilitation programs or can be used to support the adoption of cleaner technologies.

2.3 Economic Instruments for Pollution Control

This section provides a brief taxonomy of economic instruments. In each case we provide a description of the instrument, a set of guidelines for its application, and some comments on its shortcomings and limitations.

2.3.1 Environmental Fees

Environmental fees (or environmental charges) assign an explicit price per unit of pollution. An environmental fee is essentially a per unit tax on pollution. These fees can be applied in a wide variety of situations and can be levied a variety of ways. For example, an emissions fee can be applied to each tonne of sulfur dioxide emitted from a power plant; a carbon tax can be levied on each liter of petrol sold; a waste collection fee can be levied on each bag of garbage collected; a congestion fee could be charged for entry into a heavily used recreation area. The purpose behind these fees is to ensure that the price paid by the user of the environmental resource reflects the true social cost of that use.

(a) Design Principles

(i) Targeting the Source of Damage

An environmental fee should be applied as nearly as possible to the source of the environmental damage. For example, suppose an industrial effluent contains mercury, a toxic heavy metal. The effluent fee should be applied to the volume of mercury discharged and not to the total volume of effluent. Charging a fee on total effluent volume creates an incentive for the firm to reduce the total volume of effluent but this may or may not lead to a lower discharge of mercury. In particular, an effluent fee levied on total effluent volume may simply lead to a diversion of water from the effluent, leaving the same volume of mercury concentrated in a smaller volume of effluent. This has no real environmental benefit since the source of damage in this example is the mercury.

This also means that an industrial effluent comprising a variety of polluting substances should be priced on the basis of its constituent pollutants. That is, each pollutant should have its own associated fee and that fee should be payable on each unit of the pollutant.

(ii) Setting the Fee to Reflect Marginal Damage

The objective of pollution pricing is to internalize the environmental cost of that pollution. This leads polluters to balance the benefits of the polluting activity with the true social cost of the activity. Thus, an environmental fee should ideally be set to reflect the environmental damage caused by an additional unit of the pollutant (that is, marginal damage).

Of course, as noted earlier, uncertainty about the extent and value of environmental damage from a particular pollutant may be a major obstacle to full marginal damage pricing. Nonetheless, three practical application guidelines stem from the marginal damage pricing principle:

- All polluters whose discharges are equivalent in terms of environmental impact should be charged the same environmental fee. This is essential to ensure the correct distribution of abatement across sources.
- The environmental fee on a particular pollutant may need to vary according to time and location. The environmental impact of a given pollutant may differ across geographical location and across time. For example, wastewater discharged into a lake from which people draw their drinking water will likely cause greater damage than the same pollutant discharged into a heavily flushed ocean. The fee attached to the pollutant in each case should reflect that difference. In addition, a given pollutant may cause more damage at a particular time of day or year, or under particular weather conditions. In principle, the fee charged should be adjusted accordingly.
- A higher per unit fee may be warranted when the total volume of pollutant discharged is large. Environmental damage often exhibits "strict convexity", which means that the damage done by a unit of the pollutant is higher when added to an already large volume than when it is the first unit. This reflects threshold effects in the assimilative capacity of an ecosystem. Environmental fees should ideally reflect that property of environmental damage.

It is also important to note the distinction between applying environmental fees to reflect true social costs and applying user fees to achieve "cost recovery". Cost recovery usually refers to the setting of prices to recover the financial costs of an environment-related service, such as garbage collection or wastewater treatment or park maintenance. However, these financial costs do not necessarily reflect true social costs. Environmental fees can play a role in financial cost-recovery (as discussed earlier in section 2.2.3) but financial cost recovery is not their primary purpose.

We noted earlier that a key advantage of economic instruments is that they enhance incentives for cleaner technology adoption. This point is taken further in some quarters to argue that environmental standards should be tighter (and by extension, environmental fees higher) than is warranted based on environmental damage alone, with the aim of pushing firms to establish a “strategic market leadership” with respect to the innovation of cleaner technologies. This is a very dubious argument, especially in a developing country context. Moreover, *if* a case can be made for stimulating innovation for strategic trade reasons, then direct subsidization is likely to be a better policy approach. (See paragraph (vii) below). In general, it is inadvisable to set artificially high environmental fees for the purpose of stimulating “strategic market leadership” in cleaner technology development. Environmental fees should be based on environmental damage.

(iii) Revision of Fees in Response to Changing Conditions

Environmental regulation is a dynamic process: regulatory policy must be continually monitored, evaluated and revised as necessary in response to changes in economic and environmental conditions. A number of specific dynamic issues arise with respect to the application of environmental fees:

- Environmental fees must be adjusted in response to inflation. All other things equal, fees should be indexed to the rate of general inflation.
- Environmental fees should be adjusted in response to new information about environmental damage.
- In instances where damage is believed to be “strictly convex” (see paragraph (ii) above), an expansion of the polluting activity may call for an increase in the per unit fee, while the adoption of a cleaner technology that leads to lower levels of pollution may call for a reduction in the per unit fee.

(iv) Phase-In Over Time

The costs of adjusting behavior in response to newly introduced environmental standards, or newly tightened standards, can be very high for producers and consumers. These adjustment costs can be reduced substantially if progressively tighter standards are phased in over time. In the case of environmental fees this means a gradual raising of fees over time beginning from some initial introductory level. It is crucial that the planned time profile of fees be announced to the affected parties; surprise changes should be avoided whenever possible.

(v) Revenue Ear-Marking

As noted in section 2.2, one advantage of economic instruments is their potential to raise revenue. This is especially true of environmental fees. While all government revenue should in principle be directed to its most valuable use, there are three reasons why it can make sense to dedicate (or "ear-mark") the revenue earned from environmental fees, and in particular, to ear-mark it for the subsidization of cleaner technology adoption within the affected industry:

- Earmarking funds in this way can ease the political acceptance of environmental fees.
- The subsidization of cleaner technology adoption can help to offset cost increases for regulated firms and thereby protect their international competitiveness.
- Limited access to capital markets, imperfections in R&D related markets, and strategic trade considerations can *sometimes* justify the subsidization of R&D and new technology adoption, although it must be stressed that this depends on the particular circumstances in the industries concerned. Recycled environmental fee revenue can help to finance that subsidization.

(vi) Administration Costs: a Two-Part Tariff

While an environmental fee system is not necessarily more costly to administer than command-and-control policies, administration costs nonetheless exist. These can potentially be funded out of general revenue but there are many competing claims for those funds. An alternative is to finance administration costs directly through the environmental fee system. However, this should be done through a *two-part tariff*. That is, the per unit environmental fee should be set according to the guidelines above, and a separate administration fee should be levied on each polluter. This administration fee should be based on the actual cost of administering the system for each firm concerned and should not be tied to the volume of pollution.

(vii) Consultation and Cooperation

Environmental regulation of any type is likely to evoke less opposition and cause fewer implementation costs if a non-adversarial approach is taken by the regulator. Industry, consumer and environmental groups should be consulted and involved, at least to some extent, in the design and setting of fees. Naturally there will be conflict among the various stakeholders, and between stakeholders and the regulator, regarding the appropriate level and design of emission fees, but their views should nonetheless be solicited and considered.

Two key points should be emphasized to stakeholders and to the public at large in making a case for environmental fees:

- Environmental fees do not constitute a "tax grab" by government, nor should they be viewed as "buying a right to pollute". They should properly be viewed as a payment for the use of a publicly owned environmental resource.
- Environmental fees are a cost-effective regulatory instrument and reward innovative dynamic firms relative to uniform standards. Emission fees give firms flexibility in addressing the environmental impacts of their business and can thus potentially reduce the costs of environmental compliance in the long run relative to uniform standards. This is especially true if the revenue from fees is recycled within an industry.

(b) Limitations and Shortcomings

Environmental fees have two main limitations in practice: their impact on production costs, and the informational requirements for their ideal application. These limitations are discussed in turn.

(i) Production Cost Increases

Environmental fees add to the operating costs of the regulated firms. There are two elements to this cost increase. First, real resources must be diverted into reducing pollution regardless of which policy instrument is used to induce that reduction. This is the *cost of abatement*. As noted in section 2.2, economic instruments like environmental fees can implement environmental targets at lower aggregate abatement cost than uniform standards. Thus, while environmental fees do lead to an increase in production costs, that increase is smaller on average less than would occur under uniform standards to achieve the same environmental benefit.

However, there is a second element to the cost increase associated with environmental fees: the fee payments themselves. The payment of environmental fees to the government does not constitute a real resource cost to the economy as a whole; the fee payments are simply a *transfer* from the regulated firms and consumers to the government. In a “perfectly competitive” textbook economy, such transfers have no bearing on overall social welfare. However, real economies are often characterized by a variety of distortions that render the “perfectly competitive” model inappropriate in some industries. The two most important distortions with respect to the impact of environmental fees are imperfect competition and unemployment. These are discussed in turn.

Imperfect competition in global markets is the basis for concerns over “international competitiveness” and “strategic trade effects”. Cost increases for domestic firms can adversely affect the trading position of those firms relative to their international competitors, and depending on the industry and the nature of the global market in which it operates, this can lead to a loss of “economic rent” for the domestic economy. This means that an otherwise welfare-neutral transfer from firms to the government, such as through environmental fees, can translate into a real welfare loss for the country as a whole. However, it must be stressed that this strategic trade effect is likely to be small for many of Malaysia’s industries; it is an issue only where Malaysia-based firms have a significant global market share, and where import-competing Malaysian firms compete with large oligopolistic foreign firms on the domestic market.

The second economic distortion of relevance to the impact of environmental fees is unemployment. Production cost increases can lead firms to contract or even cease production. This means that some factors of production previously employed become temporarily unemployed. In "perfectly competitive" markets, these factors of production are quickly diverted into alternative uses and any welfare losses associated with the transition are small. However, in markets with chronic unemployment, displaced factors of production may remain unemployed for some time, and this has real welfare costs. This can be especially true of labor markets. These unemployment effects mean that the payment of environmental fees from firms to the government, which would otherwise be a welfare-neutral transfer, can have real welfare costs. However, such costs are only likely to be significant in industries or regions where there are serious unemployment problems.

In summary, strategic trade effects and unemployment effects can potentially create real welfare costs in association with the payment of environmental fees, quite separate from the cost of abatement. Whether or not such effects are significant depends on the particular industries concerned; in many cases they will not be. Even in instances where these effects are significant, the judicious recycling of revenue from environmental fees can alleviate any adverse impact. Moreover, any assessment of industry opposition to environmental fees must distinguish between justified concerns about international competitiveness and unemployment, and self-interested opposition to payment for an environmental resource that was hitherto available free of charge.

(ii) Imperfect Information

We noted earlier that environmental fees should ideally be set to reflect marginal environmental damage. In practice this is often difficult due to uncertainties over the nature and valuation of environmental impacts. While there should be ongoing efforts to resolve that uncertainty, policy decisions often must be made prior to that resolution, and it is common to set environmental quality targets. Environmental fees can in principle assist with the implementation of those targets in a cost-effective way.

However, in practice there may be significant informational obstacles to the application of an environmental fee to achieve a designated environmental target. In particular, in order to determine the level at which a fee should be set to induce a particular target, it is necessary to know how firms and consumers will respond to the environmental fee. This in turn requires some knowledge of abatement costs and this is often private information, unobservable to the policy-maker. Iterative adjustment of the fee over time ("that is, trial and error"), is one possible solution to this problem, but this approach has two significant drawbacks. First, firms in concentrated industries may respond strategically, knowing that the fee they face in the future depends on how they respond to the fee today. Second, firms and consumers may undertake costly pollution-reducing investments in response to the environmental fee which cannot be reversed if it turns out that the fee was set too high; this could lead to excessive investment. Moreover, this risk of over-investment may discourage firms and consumers from making such investments at all.

There are two alternative partial solutions to this informational problem: a combination standard-fee scheme; and emissions trading. These are discussed in the following two sections.

2.3.2 Combination Standard-Fee Schemes

A combination standard-fee scheme combines command-and-control type standards with an environmental fee. Firms must comply with a specified standard but at the same time must also pay a fee for each unit of pollution. The principle advantage of this scheme is that it ensures that pollution targets are not exceeded (assuming compliance is enforced). The principle disadvantage of course is that the targets are generally not met cost-effectively since firms do not have the latitude to respond to the fee according to their abatement costs. However, the application of the fee to each unit of pollution does create ongoing incentives for pollution-reducing technological change.

2.3.3 Emissions Trading

Emissions trading can overcome the informational problem with environmental fees. A tradeable emission permit scheme sets the quantity of aggregate emissions directly, by assigning a specific number of permits to existing polluters. Allowing those permits to be traded amongst polluters then establishes a market price for those permits. The market allows polluters with high abatement costs to buy permits from polluters with low abatement costs, and so the overall aggregate emissions target is met at a lower cost than if all polluters had to meet the same emissions standard.

Tradeable *emission reduction credits* are a variation on tradeable emission permits whereby all polluters are assigned an emissions reduction target (usually from a specified base-year level) but can buy and sell emission credits for better-than-target performance.

(a) Design Principles

(i) Market Depth and Uniformly-Mixed Pollutants

Emissions trading schemes require "deep" markets in order to function well; that is, the market for emissions should involve many different pollution sources, each being small relative to the entire market. This is best achieved by allowing unrestricted trade among polluters across a large geographical area.

However, allowing unrestricted trade may conflict with the goal of targeting local pollution problems. In particular, for some pollutants, allowing unrestricted trade within a wide geographic area can lead to "hot spots" where environmental damage is high. The essence of the problem is that the environmental damage done by a pollutant may depend on the particular geographic location at which it is emitted. Such pollutants are called "non-uniformly mixed" because they do not spread out uniformly over a wide area. Non-uniform mixing may be due to prevailing wind patterns or the particular chemical nature of the pollutant itself.

Large scale emissions trading is best suited to uniformly mixed pollutants since this allows the creation of a deep market without environmental "hot spot" problems. For this reason, carbon dioxide is the perfect candidate for a global emissions trading program. In practice, few local air quality problems are due to widely uniformly mixed pollutants and the scope for large scale emissions trading is limited in such cases. However, even in such situations, small scale trading programs that allow managed trade among even a small number of polluters can yield significant cost savings relative to a system of inflexible individual standards.

(ii) Low Transaction Costs

All markets function best when transaction costs are low. In the case of emissions trading, this means minimizing the number of regulatory barriers to trade. Requiring complicated approval processes before trades are approved can undermine an emissions trading program. Trade between polluters should be as free as possible. As noted earlier, this requirement may conflict with the need to manage trade in the case of non-uniformly mixed pollutants, and in practice it is necessary to make a balanced tradeoff between the two goals. However, if trading must be managed heavily to ensure environmental goals in the case of a particular pollutant then emissions trading may not be a realistic policy option for regulating that pollutant.[4]

(iii) Security of Property Rights

Well-functioning markets rely on the security of property rights. Once emission permits have been issued they should not be arbitrarily expropriated by the regulator. Such actions can seriously undermine the market since polluters will be reluctant to buy and sell permits if the ownership rights of those permits are not secure.

However, there will arise circumstances under which an adjustment to the supply of permits may be needed. For example, the discovery that a particular pollutant is more damaging than initially believed may call for a reduction in the volume of emissions and the number of permits. Similarly, a phased-in program of emission reductions over time may specify a gradual reduction in the number of permits issued in each year. The key to managing this sort of adjustment is to announce well-defined supply-adjustment rules at the advent of the program. In general, supply adjustment should be implemented through a buy-back program or through a proportional reduction rule.

[4] The most successful emissions trading program to date is the United States sulfur dioxide trading program. Sulfur dioxide is not a uniformly mixed pollutant due to prevailing wind patterns. However, in the interest of creating a deep market with few transaction costs, the program allows nearly unrestricted trade. This has been a crucial factor in the success of the program.

(iv) Monitoring and Enforcement

All environmental regulations need to be enforced if they are to achieve their intended environmental goals. This is particularly important in the case of emissions trading since the integrity of the market depends critically on the enforcement of property rights. Polluters will not buy permits on the market if they can surreptitiously pollute beyond the level allowed by their permit holdings without penalty.

(v) The Initial Distribution of Permits

There are a variety of ways in which permits can be issued initially. One possibility is by auction. This has the advantage of generating revenue for the government, but it also raises effective production costs for firms. An alternative is to issue permits free of charge (based on historical emissions levels or some other well-defined criterion). This implicitly assigns polluters the right to pollute up to the level of the permits awarded to them. There is of course a whole continuum of possibilities between these two extremes, with polluters being charged some fee for each permit issued to it, but possibly less than what they would willing to pay at auction. In this respect, an emissions trading program provides much more flexibility with respect to property rights assignments and production cost impacts than a system of environmental fees.

(vi) Banking

Banking allows polluters to carry forward into future years permits that are not used in the current year. Allowing banking has the advantage of smoothing the transition towards emission reduction goals, but it has the disadvantage of reducing the control the regulator has over emissions at any given time. Whether or not banking provisions should be included in a trading program depends on the relative importance of these factors under the particular circumstances.

(b) Limitations

(i) Non-Uniformly Mixed Pollutants and Thin Markets

As discussed above, large scale emissions trading works best where deep markets can be established for trading in uniformly mixed pollutants. Smaller scale trading programs can still be useful in the regulation of localized pollution problems but the consequent market thinness can detract from the value of the program.

(ii) Targets vs. Efficiency

Emissions trading programs are based on specified aggregate emission targets. These targets may or may not be based on an assessment of costs and benefits, and while the target may be met cost-effectively under an emissions trading program, there is no guarantee that the overall outcome is a welfare-maximizing one. It is important that environmental quality targets be continually reviewed on the basis of new information about costs and benefits, and that emission trading programs are designed with enough flexibility for those targets to be revised without undermining the programs.[5]

2.3.4 Deposit-Refund Schemes

Deposit-refund schemes have commonly been applied to beverage containers as a policy for reducing litter. However, their potential applicability is actually much wider. The basic idea is to attach a deposit to the price a good (such as a beverage container) that is paid by the consumer upon purchase and refunded to the consumer if the waste product from the good is returned. The objective of a deposit-refund scheme is to ensure that waste products are directed to their least-cost disposal method. Deposit-refund schemes can also be combined with a waste disposal tax by making the deposit only partially refundable.

[5] Emission trading programs can in fact contribute to information about costs and benefits because the market price of permits provides some indication of marginal abatement costs.

(a) Design Principles

(i) Setting the Deposit Value

In principle, the refundable deposit should be set equal to the difference between the social cost of the least-cost disposal method (which may be recycling or refilling) and the social cost of the disposal method that the consumer would otherwise have used (such as landfilling). If set in this way, the refundability of the deposit creates the correct incentive for the consumer to choose the least-cost disposal method: the consumer is forced to pay, in the form of the foregone deposit, if she chooses a disposal method other than the least-cost method.

(ii) Target Return Rates

It should be noted that the objective of the deposit-refund scheme is to create the correct incentives for waste disposal. This will generally not result in return rates of 100% since the cost of returning a waste product for refund may be higher than the deposit for some consumers and lower than the deposit for other consumers. If a consumer faces a very high return cost, due to storage or travel limitations, efficiency may dictate that the least-cost disposal method is in fact to not return the waste and to send it landfill or incineration instead. That is, return costs for the consumer must be recognized as an element in the social cost of the various waste management options.

Despite this reasoning with respect to the social cost of alternative disposal methods, uncertainty over cost valuations may lead actual policy to nonetheless focus on a targeted rate of return. If so, then it is crucial to recognize that the targeted return rate and the deposit value cannot be set independently, since the return rate is an endogenous response by consumers to the deposit value. Setting a deposit value to elicit a target return rate necessitates making some estimate of the "return supply function", which may only be revealed through trail-and-error in the setting of the deposit value.

(b) Limitations and Shortcomings

The main limitation of deposit-refund schemes is the possibility of "leakage". If the scheme is confined to a limited geographical area then the risk arises of material purchased outside that region (and not subject to a deposit) entering the region for the purposes of return for a refund. There are two main ways to deal with this problem: set modest deposit values (and so reduce incentives for illicit entry of material); and establish a monitoring scheme, possibly relying on an identifying product mark or a formal written record of purchase.

2.3.5 Environmental Securities

Environmental securities are a variation on a deposit-refund scheme. This instrument can be usefully applied where there is some risk that a particular activity or development will cause environmental damage. The security (or "bond" or "assurance"), paid before the activity is undertaken, is refunded if, and only if, no damage occurs. For example, an oil tanker may be required to pay a security prior to entering national waters, and that security is refunded only if no oil spill occurs while it is in those waters. Similarly, a mining development may be required to post a security that is refunded only if appropriate restoration work is undertaken upon completion of the project. The security creates an incentive for the potential polluter to engage in appropriate precautionary action to prevent an environmental accident from occurring.

The same incentive could, in principle, be created with an *ex post* fine should a negligent act occur. Such a fine would be set equal to the cost of the damage, much like an environmental fee. However, in practice polluters are often "judgement proof" after a major environmental accident or negligent act; that is, they do not have sufficient capital to allow payment of the damage-based fine. Fully aware that they will in fact be judgement-proof *ex post*, firms do not treat the nominal fine as a credible threat, and so it does not create the correct incentives *ex ante*. The main purpose of an environmental security is to circumvent this *ex post* judgement-proofness problem.

(a) Design Principles

(i) Setting the Security Value

If *no ex post* fine can be levied credibly, then in principle the security value should be set equal to cost of the damage that would arise from an accident or other negligent act. This fully internalizes the risk of environmental damage. If instead an *ex post* fine can be levied then the security deposit should be set equal to the damage less the value of *the ex post* fine.

(ii) Payment of Interest

The security should be refunded with interest. Alternatively, if the time horizon of a potential accident is well-defined, the security value can be discounted by the value of the interest over that horizon.

(b) Limitations and Shortcomings

(i) Uncertainty about Damage

In many cases the cost of damage should an accident occur will not be known ahead of time since this may depend on the seriousness of the accident and the particular conditions under which it occurs. In such cases the best that can be done is to set the security equal to the expected cost of an accident. Estimates of likely damage can sometimes be based on information from previous similar accidents but in other cases there will be little information on which to base an estimate.

(ii) Limited Investment Funding

A security deposit adds to the funding that firms need to raise to fund a project, and firms have only limited access to such funds. This is not necessarily a problem in well-functioning capital markets since the risk of an environmental accident should be included in the assessment of the risk associated with an investment project and fully reflected in the lending conditions accordingly. However, where capital markets do not function well, adding to the funding requirements of firms can place additional obstacles in the way of worthwhile investments. Unfortunately, there are few solutions to this problem. An obvious partial solution is to use a combination of an *ex post* fine and *an ex ante* security deposit to reduce the necessary size of the security. Beyond that, a pragmatic balanced approach is to set a lower security than would ideally be set in the context of well-functioning capital markets. The problem of financing security deposits could also be alleviated through the fostering of an environmental insurance market.

2.3.6 Abatement Subsidies

Abatement subsidies are payments made to polluters in return for emission reductions. Such payments may be direct or indirect, such as through tax concessions. Abatement subsidies can take two broad forms:

- *performance subsidies,* based on per unit reductions in pollution; and
- *technology subsidies*, based on the adoption of cleaner production or pollution-control techniques.

Technology subsidies are not economic instruments in the proper sense since they do not place an explicit price on pollution. Thus, while technology subsidies can be a valuable policy instrument under some circumstances, they are outside the scope of this report.[6]

The design principles for abatement performance subsidies are few and simple: in most situations they should not be used. An abatement performance subsidy paid to polluters has an incentive effect for an individual polluter similar to that associated with an environmental fee. It creates a price on emissions in the sense that that the polluter incurs an opportunity cost (in the form of the foregone subsidy) for each unit of pollution created. However, abatement performance subsidies have an important shortcoming: they can encourage excessive entry into a polluting industry, and can therefore potentially have a perverse effect on aggregate emissions. The problem is that the subsidy reduces average production costs and thereby makes entry into the industry more profitable.

The "entry problem" associated with subsidies can be circumvented to some extent by limiting eligibility for the subsidy to existing firms. However, this creates some other problems. First, additional instruments are then needed to regulate new firms and eventually a complex patchwork of regulations develops, with different instruments being applied to different firms depending on their vintage.[7] Second, abatement performance subsidies can distort incentives for cleaner technology adoption.

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[6] Examples include accelerated depreciation rules for pollution control equipment, accelerated retirement programs for polluting vehicles, subsidies for switching to cleaner fuels or energy efficient appliances or less polluting transportation modes, etc.

[7] Abatement technology subsidies do not necessarily suffer from the same problem since they can be applied in a one-time manner to bring older firms up-to-date. It is the on-going nature of abatement performance subsidies that causes problems.

The primary benefit of abatement performance subsidies relative to environmental fees is that they reduce production costs and thereby alleviate concerns over strategic trade and unemployment effects in instances where these effects might be significant. However, concerns over cost increases under environmental fees can be addressed by other means, such as the recycling of revenue. Moreover, subsidies must be paid out of government general revenue which is typically generated through traditional distortionary taxes on labour and investment. These taxes impose significant costs on the economy (so-called “deadweight losses”), and these costs can easily outweigh any benefits from the payment of abatement performance subsidies relative to other instruments. Finally, it should be noted that abatement performance subsidies suffer from the same informational problem as environmental fees.

2.4 Application to Urban Environmental Problems

The next three chapters discuss some specific potential applications of economic instruments to urban environmental problems. These chapters deal with air pollution, water pollution and solid and hazardous waste respectively.

3. URBAN AIR POLLUTION

3.1 Introduction

Air quality problems are currently most evident in Kuala Lumpur but continuing economic growth is likely to lead to worsening air quality in other urban areas unless appropriate regulatory steps are taken. Many of the worst episodes of air pollution in urban areas in recent years have been due to forest fires in Southern Sumatra and Kalimantan rather than to urban Malaysian sources. This problem is beyond the direct control of the Malaysian government. However, the smoke haze problem should not be allowed to obscure serious “home-grown” urban air quality issues. The photochemical haze that often envelopes Kuala Lumpur, for example, is mostly a self-made problem. Recent amendments to the Environmental Quality Act to facilitate implementation of the Clean Air Plan are important steps in the right direction. This chapter focuses on the potential role of economic instruments to further advance progress on urban air quality issues.

3.2 Major Urban Air Pollutants: Sources and Effects

The relative importance of various air pollutants differs across cities according to geographical characteristics and the nature of proximate economic activity. However, the largest single source of urban air pollutants is the transportation sector. This sector accounts for around 75% of total emissions (and almost all lead emissions). Emissions of most air pollutants, with the exception of lead and sulfur dioxides, have risen alongside the growth in economic activity over the past fifteen years or so. The following provides an overview of some of the most important urban air pollutants, together with their main sources and effects.

Suspended Particulates

Total suspended particulates (TSP) comprise a variety of airborne particles, both organic and metallic. The most dangerous particulates are those less than 10 microns in diameter (PM10), which can be easily breathed into the lungs. There are three main known health effects of particulates. First, they cause eye and respiratory irritation, and elevate the risk of serious lung infections. Young children and the elderly are most susceptible to such infections. Second, long-term exposure is thought to contribute to and exacerbate the effects of chronic lung diseases, including asthma, bronchitis, and emphysema, all of which cause considerable suffering and lost productivity. Third, there is some evidence to indicate a carcinogenic effect from long-term exposure to some particulates.

The main anthropogenic sources of TSP are combustion, industrial processes, and the formation of sulfates from sulfur dioxide emissions. Vehicle emissions (especially from diesel-powered vehicles and two-stroke engine motorcycles) are the single most important source of particulates in Kuala Lumpur and most other Malaysian cities. Emissions of TSP in Malaysia have not risen as quickly as in some developing countries but they nonetheless pose one of the most serious urban air quality problems.

Lead

Lead is a highly dangerous pollutant, causing illness and nerve damage, and most importantly, the impairment of neurological development in children. Motor vehicles are the main source of atmospheric lead emissions: the combustion of leaded petrol accounts for 80% to 90% of ambient air lead concentrations in most Malaysian cities, and lead levels tend be at their highest along heavy traffic routes.

Mandatory reduced lead content requirements in petrol introduced in 1985, together with a higher tax on leaded petrol introduced in 1994, have drastically reduced ambient lead concentrations and the situation continues to improve.

Ground Level Ozone

Ground level ozone is a serious eye and respiratory irritant, and causes damage to urban vegetation and building materials. It is also an important source of damage to crops and forests in surrounding areas. Ozone is produced in the atmosphere by the reaction of nitrous oxides, volatile organic compounds (VOCs) and carbon monoxide in the presence of sunlight. The main sources of these emissions are motor vehicles (see below).

Carbon Monoxide

Carbon monoxide is produced from the imperfect combustion of carbon-based fuels. It causes headache, poor concentration and lethargy, and in high doses, unconsciousness and death. The main source of carbon monoxide emissions is motor vehicles; they account for almost 100% of these emissions in most cities, and emissions are highest in peak traffic congestion periods when engines do not run efficiently.

Hydrocarbons

Hydrocarbons comprise a large group of gaseous organic compounds, produced through combustion and vapor release from fossil fuels. Among the most important are VOCs, which are catalytic in the formation of ground level ozone (see above). Exposure to hydrocarbons can cause headache and dizziness, and many hydrocarbons are suspected carcinogens. The main anthropogenic source of hydrocarbons in urban areas is motor vehicles. Like many vehicle emissions, the production of VOCs is highest at low engine revolutions, and so tends to be worse in areas of high traffic congestion.

Nitrous Oxides

Nitrous oxides are produced principally through the combustion of carbon-based fuels. Nitrous oxides are an important precipitation acidifier. In urban areas, its main contribution to air pollution is as a catalyst in the formation of ground level ozone. (See above). Motor vehicles account for most nitrous oxide emissions in Kuala Lumpur and other car-intensive cities.

Sulfur Dioxide

Like nitrous oxides, sulfur dioxide is produced primarily through the combustion of fossil fuels, particularly high sulfur coal and petrol. It is also an important precipitation acidifier. In urban areas its main impact is as a respiratory irritant. The main anthropogenic sources of sulfur dioxide are fossil fuel-fired power plants, industrial processes, and motor vehicles.

3.3 The Scope for Economic Instruments

The foregoing discussion points to the transportation sector as the single most important cause of urban air quality problems. Thus, any policy mix designed to address urban air quality must first and foremost confront the problem of motor vehicle emissions. The discussion here focuses on that issue.

The problem of vehicle emissions is intertwined with the problem of road congestion, not only in terms of aggregate miles driven, but also in terms of the pace at which traffic moves since this is an important determinant of engine efficiency, and hence, of exhaust emissions. The two issues should be viewed as related, but nonetheless separate. In particular, some policies designed to address emissions (such as emissions control technology requirements) will have little impact on congestion. The key principle behind congestion management is controlling the number of cars on the road, according to location and time of travel. In contrast, the main focus of emissions policy is the management of emissions. Policy instruments should be targeted as closely as possible at the primary source of the problem at hand, but their use should be carefully coordinated.

3.3.1 Policy Options to Control Vehicle Emissions

Changes to the Environmental Quality Regulations (Control of Emissions from Diesel Engines and Control of Emissions from Petrol Engines) in 1996 are important steps towards addressing some of the air pollution problems associated with motor vehicle use but more needs to be done.

The ideal instrument for addressing vehicle emissions is an exhaust *emissions fee* since this targets the source of the problem directly. However, it is technically difficult to monitor tailpipe emissions directly; the technology for doing so exists, but the cost of retrofitting the existing car fleet with onboard emission monitors is prohibitive.

One alternative to a direct emissions fee is an *extrapolative emission fee*. This fee is levied yearly and calculated on the basis of kilometers driven and the average emissions-per-kilometer for the particular vehicle type. This average is calculated on the basis of periodic standardized emissions testing and so is only an imperfect indicator of actual emissions. The application of these fees necessarily involves ongoing testing and regular reporting by motorists on kilometers driven.

An administratively simpler policy alternative is a *fuel tax*. The volume of some pollutants is directly related to fuel consumption but for other pollutants, such as carbon monoxide, VOCs and nitrous oxides, engine tuning, driving style and trip characteristics are also very important. For example, emissions of these pollutants are much lower in highway driving than in city driving. Thus, a fuel tax can be an imprecise instrument for addressing some pollution problems. Nonetheless, the administrative simplicity of applying and enforcing a fuel tax is a key advantage of this instrument.

The application of a tax to one type of fuel (such as petrol) will tend to cause a switch into alternative fuels (such as diesel), so any environmental tax policy must be comprehensive in scope. All fuel types should be taxed but taxes should discriminate across fuel types according to the damage they cause.

Fuel taxes should also discriminate across fuel quality. This type of discrimination is already in place to some extent with respect to lead content but it could be extended to other characteristics of fuel. In particular, petrol and diesel fuel could be taxed according to sulfur content.

It should be noted that even fuels taxes levied at a high rate will not necessarily have a significant impact on fuel use or on emissions in the short term. Experience in some parts of Europe suggests that high fuel taxes do not necessarily translate into reduced car use and cleaner air. Two lessons emerge from that experience. First, the impact of fuel taxes on emissions is likely to occur through a gradual switch to smaller, more fuel efficient cars (but as noted above, there is no guarantee that greater fuel efficiency will mean fewer emissions across the entire range of pollutants). Second, the unhappy truth may be that car drivers are willing to pay a lot for the benefits of driving. This is a problem only if the policy objective is to reduce emissions *per se*. If the objective is a broader one based on economic efficiency, then the important goal is to ensure that vehicle drivers are paying the full social cost of their driving, which does not necessarily translate into lower emission levels. That is, the costs of private vehicle driving should be weighed against the benefits in the formulation of any emissions-reduction policy.

Any attempt to price emissions, whether directly or indirectly through a fuel tax, must be cognizant of distributional considerations. In particular, lower income groups have less ability to pay and often have less flexibility to switch to newer, less polluting cars. However, the solution to that problem is *not* to ignore the pollution problem. Moreover, the costs of poor air quality often fall most heavily on lower income groups who are less able to avoid pollution by living away from heavy traffic routes or by installing effective air filtering systems in their cars and homes.

The distributional problem is best addressed by recycling revenue from pollution pricing. Two possible revenue recycling schemes are *accelerated vehicle retirement programs*, which pay a reward to the owners of old, highly polluting cars in return for scrapping those cars, and *subsidized public transit use*.

3.3.2 Policy Options to Control Congestion

Emission fees and fuel taxes are very blunt instruments for addressing road congestion since the combustion of fuel *per se* does not cause congestion. For example, zero emission (electric) vehicles cause as much congestion as vehicles of the same size powered by petrol engines. However, a variety of instruments designed to address congestion will also affect emissions since they lead to reduced car use. Some of the most important are the following.

Road tolls are likely to be effective only where there are a limited number of major thoroughfares into the city center that can be easily monitored. The much-celebrated success of the Singapore experience with electronic road pricing does not necessarily indicate that a similar system would work in Kuala Lumpur. However, such a system would be consistent with Malaysia's goal of making Kuala Lumpur an information technology-intensive city.

Parking restrictions are generally a bad policy to deal with congestion; a stream of cars circling city blocks in search of scarce parking can compound congestion problems. In contrast, *high parking fees* can be a very effective policy, and one that should be applied immediately.

Car ownership fees are already in place in Malaysia in the form of a road tax. These fees are based on engine size and fuel type and whether or not the car is fitted with pollution control equipment, and so they also address emissions in an indirect way. The design of these fees could nonetheless be improved by basing the fee on self-reported number of kilometers driven. This would involve higher administrative costs since some random auditing would be needed, but a fixed component could be included in the annual fee to fund this cost.

Tradeable vehicle ownership permits are an alternative to annual ownership fees. Their chief advantage is that they control the quantity of cars directly. Tradeable vehicle ownership permits work well in Singapore because of its naturally bounded territory; a similar scheme may not work as well for dealing with congestion in Kuala Lumpur since it would be more difficult to monitor and administer.

Vehicle purchase taxes raise the price of car ownership. This discourages the purchase of cars relative to other goods, but also discourages the purchase of new, less polluting cars relative to old, highly polluting cars. Annual car ownership fees are a superior policy to vehicle purchase taxes.

Broader planning instruments, such as land use zoning and housing density regulations, can also have a marked impact on car use (as the urban sprawl and associated car use in many world cities clearly demonstrates). Similarly, infrastructure construction policies are clearly also important, especially with respect to the balance chosen between road construction and public transit provision. These are critical elements of any integrated urban transportation plan.

While some of the policies described here could have very valuable roles to play in reducing congestion in Kuala Lumpur, perhaps the most important priority is the enforcement of traffic rules. Traffic research indicates that smooth traffic flow relies on ordered patterns of behavior; cars moving in an ordered equilibrium can flow much more smoothly than the same number of cars trapped in an unordered equilibrium. Shifting from the disordered equilibrium to the ordered equilibrium requires a decisive push from traffic enforcement authorities. Once a higher level of order is restored, it can be maintained with far less enforcement than is needed for the initial correction, and the long term benefits can quickly offset the initial cost.

4. URBAN WATER POLLUTION

4.1 Introduction

There are three main sources of water pollution in urban areas: industrial effluent, wastewater, and urban runoff. The relative importance and severity of these pollution sources varies across cities according to population densities, the nature of industrial activity in the area and geographical factors. Each of these main sources also differ in terms of which policy measures are most appropriate for their control and we therefore examine each pollution source separately in this chapter. However, it must be noted that there are important linkages between these different pollution sources and that policies aimed at addressing these problems must be tied together into an integrated water pollution control policy.

4.2 Industrial Effluent

A wide variety of industries contribute to industrial effluent, and their relative importance differs across cities. Effluent from these industrial sources contains various organic and inorganic compounds, including:

- acids and caustics
- biological oxygen demand (BOD) intensive substances
- grease and oil
- heavy metals, such as cadmium, chromium, lead and mercury
- organochlorines, including polychlorinated biphenyls (PCBs) and dioxins
- suspended solids
- various synthetic organic compounds.

Some of these toxins, including the organochlorines and most of the heavy metals, are known to cause physiological and genetic damage, reduced fertility rates, and birth defects, both in humans and other animal species. These toxins are particularly insidious because they are biocumulative (that is, they accumulate in animal fats), and so tend to become concentrated in animals at the top of the food chain (including humans). They also tend to accumulate in silt, where they can continue to contaminate waterways and bays for decades, even long after new discharges have been stopped. The environmental impacts of many other inorganic and synthetic organic compounds are entirely unknown, because they have not been fully studied.

4.2.1 Point Source versus Non-Point Source Pollution

The difficulty of regulating industrial effluent is compounded by the fact that much of the pollution originates from non-point sources; that is, the effluent cannot be traced to an identifiable point, such as a discharge pipe. Chemical pollution finds its way into drains and sewers through a variety of routes including accidental spills, illicit dumping, and infiltration from contaminated groundwater. Atmospheric emissions also contribute to non-point source water pollution through the contamination of precipitation. Non-point source pollution can be particularly difficult to regulate because policy instruments cannot be targeted directly at the source of the pollution, since the source is unidentifiable.

4.2.2 The Scope for Economic Instruments

The best candidates among economic instruments for the control of industrial effluent are *environmental fees* and *deposit-refund schemes*. Malaysia has already had some success with the use of effluent fees in the palm oil industry and it is worth briefly reviewing some of the merits and deficiencies of that program.

Effluent fees for the palm oil industry were introduced in 1974. These fees are tied to the BOD content of effluent. The fee system is combined with a minimum BOD performance standard and so the policy is not a pure environmental fee in the sense described in chapter 2. For this reason the fee system does not allow the full efficiency gains attainable by allowing mills to respond freely to the fee. However, combining the fee with a standard ensures that effluent targets are met with much more certainty than would be possible with a fee alone. The main benefit of the fee system is its effect on incentives for technological change. In contrast to a performance standard alone, firms face a price for every unit of BOD and so have ongoing incentives to reduce their BOD effluent even if they are in compliance with the standard. Technological change has in fact been the key to the dramatic reductions in BOD pollution from the palm oil industry over the past twenty years, although this technological response is probably attributable more to the pre-announced progressive tightening of the performance standards over time than to the incentive effect of the effluent fee *per se*. Nonetheless, part of the fee is channeled directly into financing technological innovations, and this revenue recycling has been very important in fostering technological change.

The principal shortcoming of the fee system is the manner in which it covers administrative costs. A minimum effluent fee is charged regardless of actual effluent in order to cover administration costs. This provides no incentive for firms to reduce their effluent below the level corresponding to the minimum fee. A better system would detach the administration fee entirely from the effluent fee itself.

The hybrid nature of the palm oil effluent fee system means that it provides only an imprecise indication of how a pure environmental charge system might work in other applications. The severity of the pollution problems associated with the palm oil industry in the early 1970s gave the Department of Environment little room to experiment with a less-constrained pure fee system. However, the successful palm oil industry experience should encourage further and bolder policy experiments with effluent fees in other industries.

Any such experiments should take account of two important limitations to the application of effluent charges to industrial effluent. First, some types of industrial effluent may be so dangerous that a cost-benefit analysis would indicate that zero discharge levels are optimal. A complete ban may be appropriate in such cases. Nonetheless, effluent fees can play a key role in facilitating the gradual phasing out of those substances by fostering and financing technological change through revenue recycling.

Second, the successful application of effluent fees is limited to point sources where effluent discharges can be monitored. These conditions are not always satisfied. The effluent may be non-point source by nature, or equally important, illicit dumping may be difficult to detect and provide firms with a low cost means to avoid effluent discharges.

In instances where effluent monitoring is problematic, the application of environmental *fees on polluting inputs* may sometimes be a feasible alternative. This approach can be especially effective when there is a clear linkage between input use and effluent produced (such as with chlorine use and dioxin effluent from pulp and paper mills) and where inputs have a "market trail" that can be monitored more easily than effluent.

Environmental charges on polluting inputs should be applied in the form of a *deposit-refund scheme* whenever possible. Such a scheme refunds the environmental fee on inputs (or transformed inputs) that are recovered in the production process. This ensures that the firm is charged only for polluting inputs that are discharged in the form of effluent and so creates an incentive for firms to improve their recovery process.

4.3 Wastewater

Wastewater treatment is currently privately operated in many parts of Malaysia. This privatization has been motivated principally be a cost-recovery goal. Treatment fees are typically not related to the marginal cost of treatment; they are mostly fixed charges, often based on property value.

A number of key points need to be recognized with respect to the design of policy on wastewater treatment. First, as noted in Chapter 2, "cost-recovery" is generally not the same thing as full-cost pricing. Cost recovery in the case of wastewater treatment typically involves charging fees to users that in aggregate cover the financial costs of supplying treatment. The cost of any environmental damage associated with the imperfect treatment of wastewater is an external cost and is not reflected in the financial costs incurred by the treatment provider and so is not passed on to users of the treatment service. Thus, the privatization and pricing of wastewater treatment services in itself does not necessarily address the associated water pollution problems. An environmental fee should be levied on treated sewerage based on its pollution costs.

Second, wastewater treatment and water supply are closely related issues. Where water is metered, the price of water usually reflects only the cost of supply. However, if monitoring difficulties prevent the pricing of wastewater disposal directly at the household and firm level, then the price of water should reflect the true social cost of supply and disposal. Thus, the price of water should ideally be set equal to the marginal cost of supply plus the marginal cost of post-usage treatment plus the marginal cost of post-treatment damage. The difficulty of individual monitoring means that treatment and post-treatment costs have to be based on average waste loads across the users in any given disposal network.

Third, the pollution costs of imperfectly treated wastewater can differ significantly across different situations. Two factors are particularly important in this regard. First, the medium into which wastewater is discharged can be important. For example, deep ocean discharge may be less damaging than discharge into a river or lake that has relatively little natural flushing. Second, the ecological and human use of the discharge medium is important. For example, the cost of discharge into a lake that is used for drinking water by a large number of people is likely to be high. This variance in pollution costs means two things: (i) a uniform standard for treatment requirements in all areas of the country is generally not appropriate; and (ii) the environmental charge on post-treatment discharge should generally vary across different wastewater disposal networks.

Fourth, water supply and wastewater treatment are natural monopolies over a certain market size, due to the significant fixed costs associated with supply and disposal infrastructure. That is, the least-cost way to supply water and treat wastewater is with single service providers. This means that both water supply and wastewater treatment need to be regulated to ensure that monopolistic power is not exploited. This is a complicated policy problem and one that is beyond the scope of this report. However, the levying of an environmental fee for post-treatment pollution must be carefully integrated with the overall regulatory framework for these utilities.

4.4 Urban Runoff

Rainwater runoff carries a variety of pollutants into urban rivers and other water bodies either directly or through street drainage systems. Among the most important sources are

- oil and grease washed off roads
- illicit disposal of chemical pollutants through street drains
- street litter

- sediment associated with land development.

These pollutants are difficult to monitor and control due to their non-point source nature. However, economic instruments can nonetheless play an important role in regulating these pollutants. The most important of those instruments in these cases is a *deposit-refund scheme*. Deposit-refund schemes have long been used to control litter in many countries and there is scope for their wider application in Malaysia. Such schemes are also applicable to a variety of other potential pollutants, including oil, paints, solvents and other potential chemical pollutants.

Of course, the implementation of a deposit-refund scheme must be accompanied by the establishment of an effective return system. If firms and individuals find it too difficult or time-consuming to return substances like used motor oil and unused paints, then there will be little incentive for them to do so, despite the foregone deposit. The most natural return point for the consumer is likely to be the original retailer. Centralized return and disposal depots must then in turn be available to retailers. Such a system can be costly and those costs must be weighed carefully against the cost of the runoff pollution associated with these substances in deciding upon the scale and scope of a deposit-refund scheme.

Economic instruments are generally not appropriate for controlling sedimentation problems. The best regulatory approach to this problem is likely to involve standards on clearing and building practices, enforced by the threat of penalties.

5. SOLID WASTE

5.1 Introduction

This chapter deals with hazardous and non-hazardous solid waste. While these two waste types generally require very different disposal methods, the types of economic instruments applicable to their regulation are similar. Moreover, poorly designed regulation can lead to an inadequate separation of toxic and non-toxic solid waste, with potentially dangerous consequences. Thus, toxic and non-toxic solid waste management policies must be designed in harmony.

5.2 Non-Hazardous Solid Waste

Malaysia is currently moving towards a private waste management system to be operated by four major consortia (Alam Flora Sdn Bhd for Kuala Lumpur, Selangor, Pahang, Kelantan and Terengganu; Konsortium Comsec Gali for Johor, Negri Sembilan, and Malacca; Konsortium KK Industries for Perak, Kedah, Penang and Perlis; and Malaysian Mining Corporation for Labuan, Sarawak and Sabah). This privatization program should foster cost-effective solid waste management but privatization should be viewed as complementary to regulatory policy in the area rather than as a substitute for such policy.

The solid waste management problem is not simply one of waste disposal. It is crucial to view the waste management problem as one involving a flow of materials that begins with the production and consumption of goods. It is helpful from a policy perspective to partition that flow of material into four main stages:

- waste generation;
- waste separation and diversion;
- waste collection; and
- waste disposal.

We discuss each of these in turn.

5.2.1 Waste Generation

There are three key issues relating to the waste generation stage: the volume of waste, the composition of waste, and source mix of waste.

The Volume of Waste

The volume of waste generated is a direct function of the volume and type of material used in the production and packaging of goods. It is important to recognize that the full social cost of consuming these goods includes the cost of any necessary subsequent disposal. If that cost is not fully reflected in the private cost of consuming (in terms of the price paid for a good at the point of purchase, plus the private cost of disposal), then the volume of material entering the waste stream will generally be excessive relative to what is efficient.

The Source Mix of Waste: Households vs. Commercial Sources

The share of waste produced by households versus commercial sources is also important from a policy perspective, since it determines to a considerable degree the concentration of waste sources for collection purposes, and it also determines how the generation of waste will respond to various policy instruments; households and commercial sources are likely to respond quite differently to a given instrument. Moreover, the incentives at play are likely to differ across different types of commercial sources, such as manufacturing industries, merchants, construction sites, public markets, etc.

The Composition of Waste

The breakdown of waste between households and commercial sources, and the breakdown across different commercial sources, also affects the composition of the waste entering the waste flow. Of particular importance are the distinctions between toxic and non-toxic waste, and biodegradable and non-biodegradable waste. The environmental impacts, the appropriate collection methods, and the best disposal methods for these different waste types are generally quite different. If the cost of disposal according to waste type is not reflected in the private cost of consumption then the composition of material used in the production of that good, and in its packaging, will generally not be efficient.

5.2.2 Waste Separation and Diversion

The diverse composition of waste entering the waste stream makes the separation and possible diversion of waste a critical aspect of solid waste management. In an ideal world, all waste would be finely separated into waste classes according to its suitability for reuse and recycling, and otherwise according to the most appropriate disposal method for the waste type. However, it is important to bear in mind that separation of the waste stream into different waste classes is costly. The appropriate degree of separation must be determined according to a careful consideration of the attendant costs and benefits, rather than according to some preconceived notion of what is "environmentally sound". In particular, the diversion of reusable and recyclable waste from the waste stream should generally *not* be pursued as a waste management goal in its own right. Separation and diversion is worthwhile only if the social cost of disposal exceeds the net cost of separation and diversion. Nonetheless, waste separation and diversion has a key role to play as part of an integrated waste management strategy. The optimal degree of separation and diversion will depend on the particular circumstances of the urban area involved.

Much of the material entering the waste stream is potentially suitable for *reuse*, either by the primary source of the waste, or by a second party. The important policy issue relates to whether or not there is enough reuse of waste material based on the costs and benefits involved.

The degree of recycling (and composting) should also be based on a proper assessment of costs and benefits. The fact that a waste type is recyclable does *not* mean that it should necessarily be recycled. In particular, if the net social cost of recycling a particular material (that is, the full cost of recycling less the value of the recycled material) is more than the social cost of disposal in a landfill or incinerator, then the material should be landfilled or incinerated rather than recycled. The key policy issue relates to whether or not the private costs and benefits associated with recycling reflect the true social costs and benefits.

5.2.3 Waste Collection

The main policy issues with respect to waste collection relate its implementation and financing.

Public vs. Private Collection

The institutional arrangements for collection, in terms of the mix of public versus private service, and the nature of contracts between public authorities and private agencies, will generally have important implications for cost-effectiveness, for the scope and quality of service, and for the effectiveness of policy instruments targeted at other stages of the waste stream.

Collection Scope

If programs are put in place to separate waste types in the waste stream then there arises the question of whether or not collection service should extend to recyclables, separate from the collection of garbage. This depends to a large degree on the policies used to price collection.

Financing

Financing the cost of providing collection services poses a serious obstacle to service expansion, both in terms of scale and scope. Local authorities usually have very modest tax bases, and are often unable to collect taxes at all in the poorest areas, especially when the poorest settlements lie outside official city boundaries. Revenue-generating economic instruments and privatization can help to finance waste collection.

5.2.4 Waste Disposal

There are a number of important issues with respect to waste disposal, relating both to institutional arrangements and to disposal technology.

Public vs. Private Ownership and Management

There is no particular reason why the same institutional arrangement should apply to both collection services and disposal sites, and the private construction and ownership of waste disposal facilities is a potentially sensible arrangement under some circumstances.

Incineration vs. Landfilling

The suitability of one disposal method over another depends on a host of factors, the most important of which are the availability of proximate sites relative to population concentrations; the geographical characteristics of the region, especially with respect to air patterns and ground and surface water drainage patterns; and the composition of the waste. Unsanitary landfills can pose serious surface and groundwater contamination risks, especially if they are used for toxic waste disposal. The use of garbage for "land reclamation" can cause pollution to surrounding coastal areas, and can render the "land" too contaminated for any valuable eventual use.

Site Location

There is an important tradeoff between the cost of transporting waste to areas beyond population concentrations, and the cost associated with locating disposal sites where large numbers of people are exposed to the noxious fumes and potentially far more dangerous hazards.

Financing

Lack of financing for the construction and operation of disposal facilities means that state-of-the-art landfill and incineration systems, whose associated environmental impacts are much lower than for older technologies, may be out of reach in many areas, especially in urban areas outside the relatively wealthy cities.

5.2.5 The Role for Economic Instruments

There is a role for economic instruments at each stage of the waste management chain. The key to their use is to choose the correct instrument for the desired purpose.

Product Taxes

Product taxes are directed at the waste generation stage of the waste chain. A tax based on the social cost of disposal of the associated waste will shift demand towards goods that are less solid waste-intensive. The extent to which that demand pressure translates into pressure on producers to change the nature and packaging of their products depends to a considerable degree on market structure and the size of the jurisdiction over which the policy is applied. Product taxes applied at the level of an individual urban authority are likely to have no effect on production practices. Moreover, product taxes affect waste disposal practices only indirectly, in the sense that they change incentives with respect to the type of product purchased according to its waste profile. However, once a product is purchased, the product tax paid has absolutely no effect on incentives with respect to disposal method choice for the purchaser; a product on which a tax has been paid is just as likely to end up being dumped as one on which no tax has been paid.

Deposit-Refund Schemes

Deposit-refund schemes are intended to affect incentives with respect to waste stream decisions once product purchases have been made. They are not aimed at reducing the volume of waste (although they do create incentives with respect to the composition of waste generated). The idea is to divert recyclable and reusable material from the waste stream.

Deposit-refund schemes are an excellent policy choice for implementing waste diversion targets. Moreover, if the deposit is set equal to the difference between the marginal social cost of garbage collection plus disposal, and the net marginal social cost of recycling, then the scheme will implement the efficient degree of waste diversion. In particular, the material will only be returned if the cost of diversion (including separation and storage costs) is less than the deposit, and hence, less than the social benefit of diversion.

Deposit-refund schemes also make effective use of markets. In particular, private services naturally develop through which dealers collect refundable material from people unwilling to incur the inconvenience of returning the material themselves, to the mutual benefit of both parties.

It is worth stressing that deposit levels and targeted return rates cannot be set independently, since one is a market equilibrium response to the other: a higher deposit will elicit a higher return rate.

Subsidized Collection of Recyclables

Subsidized collection of recyclables is the subsidy equivalent of a deposit-refund scheme: the deposit-refund scheme imposes a penalty (the foregone deposit) if the material is not returned for recycling, while the subsidized collection of recyclables rewards recycling directly. Subsidized recyclables collection is an inferior policy to a deposit refund scheme, for two reasons: first, it is revenue-negative for the subsidizing government; and second, it can actually have a perverse effect on the overall volume of waste, since the subsidy on recycling effectively reduces the cost of waste disposal for the consumer of the product.

One important qualification is needed on this judgement of recyclables collection subsidies. If the subsidy is attached to the fixed costs of recyclables collection rather than the marginal cost, then a subsidy can help to overcome a potential inefficiency associated with private incentives in the face of economies of scale.[8]

Volume-Based Pricing

This instrument attaches a price to the disposal of garbage and so creates incentives for garbage reduction, both through waste diversion and through reduced waste generation. In principle, the collection fee should be set equal to the marginal social cost of collection and disposal. In many circumstances, volume-based pricing is an excellent policy instrument, and it has been very successful in many applications in OECD countries.

However, there are two potential drawbacks with this policy instrument. First, it can induce dumping and household incineration since these disposal methods may be a lower cost alternative for many people. This is especially likely if an area is already highly littered since the social stigma associated with dumping is much less in that case.

[8] Efficiency requires the equality of marginal costs and benefits. The existence of significant fixed costs can mean that marginal cost and marginal benefit are equated where total private cost is greater than total

Second, volume-based pricing, as opposed to weight-based pricing may encourage garbage compression. However, this may not necessarily be a serious problem, because some of the costs of garbage disposal are in fact more closely related to volume than to weight.

An additional consideration in favor of volume-based pricing is that it is revenue-positive for the collecting authority, and can therefore help to defray the financial costs of collection and disposal.

Tipping Fees

Policies at the disposal stage are not designed to influence incentives for households and other waste sources; rather, they are designed to ensure that disposal sites are located and constructed in an appropriate manner. Note that the use of tipping fees (imposed on private waste collectors) can help to encourage disposal at least-cost facilities if the tipping fees are chosen to reflect the true cost of disposal, inclusive of the costs associated with noxious fumes to neighboring residents, and any other air or water pollution associated with poor quality facility design or construction.

5.3 Hazardous Solid Waste

The appropriate method of disposal for non-toxic solid waste, such as paper and food scraps, is very different from that for hazardous waste, such as certain building materials, contaminated materials (such as paint rags and fabric filters), discarded batteries, industrial ash, medical waste and radioactive waste. In particular, the disposal of hazardous waste in landfills can cause surface and groundwater contamination, and soil contamination, while their disposal in low-temperature incinerators, designed for non-toxic materials, can produce dangerous atmospheric emissions. To reduce the risk of environmental damage, hazardous waste must be treated prior to disposal (such as in the removal of acids and heavy metals from dead batteries), or incinerated at very high temperatures, or stored or buried in sealed, durable containers. Implementing this differential treatment of waste requires that waste types be separated prior to collection,

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private benefit even though total social benefit exceeds total social cost. (This is the so-called "natural monopoly problem").

since it is generally too costly to separate waste by type once it is taken to disposal sites as an aggregated mixture.

5.3.1 Policy Options for Managing Hazardous Waste

The most common policy goal for many types of hazardous waste (or "scheduled waste") is to ensure its proper disposal, although reducing the quantity of waste produced should also be an important consideration. The setting of standards for labeling, storage, transportation and final disposal of these waste types are the main policy instruments available. These standards must be enforced by threat of penalty for non-compliance.

This command-and-control approach can be usefully supplemented in some instances with *deposit-refunds schemes*. These schemes are most applicable for hazardous waste management where there is a clear relationship between the inputs used in a production process and the hazardous waste generated. A deposit paid on the inputs in question is refunded only if the hazardous waste is disposed of in an appropriate manner (such as at a licensed incineration or waste processing plant).

Security deposits are a variation on a deposit-refund scheme, and these can be particularly useful for creating incentives for exercising due care during the storage and transportation of hazardous waste. A security is posted prior to storage and transportation, and that security is refunded only if the waste eventually reaches a disposal facility without accidental leakage or spillage.

One of the main problems in the management of hazardous waste is the cost of constructing and operating disposal facilities. Incineration, waste processing, and secure landfill disposal are all extremely expensive. Malaysia has made significant progress in this regard through the use of public-private partnerships in the financing and operation of disposal facilities. Revenue-generating economic instruments can be used to good advantage in conjunction with such partnerships. *Environmental fees* on the production and disposal of hazardous waste can assist with the financing of these costs, and at the same time can create incentives for reduced waste generation.

Such fees must be used carefully lest they induce dumping. In particular, imposing a high disposal fee at a secure landfill can create an incentive for firms to find "alternative" disposal means, especially if there is limited monitoring. This perverse effect of a disposal fee can be moderated if it is used in conjunction with a deposit-refund program, since the loss of a deposit raises the private cost of illegal disposal. Moreover, where there is a clear relationship between inputs and hazardous waste generated, disposal-financing taxes can be imposed on inputs without distorting hazardous waste disposal choices. Requiring that records be kept of input purchases can also assist with monitoring the disposal of hazardous waste.

6. CONCLUSION

The current economic climate means that it is more important than ever that Malaysia manage its environment in an efficient manner. Economic instruments can play an important role in achieving that goal, especially with respect to the management of urban environmental problems. This report has focussed on three areas in particular: urban air pollution, urban water pollution, and solid waste management. The key points and recommendations of the report can be summarized as follows.

Advantages of Economic Instruments

Economic instruments are policies that attach an explicit price to pollution and environmental resource use. They are not a panacea for all environmental management problems and they are best used in concert with a range of other policy tools. Nonetheless, economic instruments have a number of potentially significant advantages over command-and-control type policies:

- cost-effective implementation of environmental quality targets
- enhanced incentives for ongoing pollution-reducing technological change
- potential revenue generation

Economic Instruments for Air Pollution Control

The predominant source of urban air pollution is the transportation sector. Management of this sector must recognize the inter-relatedness of vehicle emissions and congestion. Policies designed to deal with these two issues are distinct but necessarily related, and so must be closely integrated.

Economic instruments that can be used to target *vehicle emissions* include:

- emissions fees
- extrapolative emission fees
- fuel taxes

These instruments can be supplemented with other policies to help manage the distributional effects of economic instrument use. Two such policies are

- accelerated vehicle retirement programs
- subsidized public transit use

Economic instruments that can be used to target *traffic congestion* include:

- road tolls
- parking fees
- car ownership fees
- tradeable vehicle ownership permits

Economic Instruments for Urban Water Pollution

The regulation of water pollution is complicated by the fact that much water pollution is non-point source. There are three principal sources of urban water pollution:

- industrial effluent
- wastewater
- urban runoff

Economic instruments for controlling *industrial effluent* include

- effluent fees
- polluting input fees
- deposit-refund programs

The regulation of *wastewater* should generally be tied to the supply of water since wastewater discharges are costly and difficult to measure. The price of water should reflect the cost of supply plus the cost of post-use treatment plus the cost of post-treatment environmental damage. Privatization should be viewed as a complement to wastewater policy rather than as a substitute for such policy.

The most effective economic instrument for dealing with *urban runoff* is a deposit-refund program. The purpose of such a program is to divert material into the controlled waste stream that would otherwise find its way into waterways as street runoff.

Economic Instruments for Solid Waste Management

The solid waste stream for can be usefully partitioned into four main stages:

- waste generation
- waste separation and diversion
- waste collection
- waste disposal

Different policies are called for at each stage of this waste stream. Economic instruments that can play a role in solid waste management include:

- product taxes
- deposit-refund programs
- subsidized collection of recyclables
- volume-based collection pricing
- tipping fees

A crucial element of the solid waste management is the separate treatment of hazardous and non-hazardous waste. Economic instruments best suited to the management of hazardous waste are

- deposit-refund programs
- security deposits
- environmental fees