IMF WORKING PAPER

WP/93/27

INTERNATIONAL MONETARY FUND

Fiscal Affairs Department

Public Expenditure Policy and the Environment: A Review and Synthesis

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March 1993

Abstract

Commonly cited environmental instruments in the legal, regulatory, and fiscal domains are intended primarily to address market failures to ensure that environmental degradation and resource use is contained to appropriate levels. However, in many instances, environmental degradation is rooted not in market failure, but rather in policy failure. This paper identifies areas of public expenditure policy that interact with the environment. It argues that a reform of certain types of subsidies, increased operations and maintenance expenditures, and a thorough environmental assessment of capital projects will tend to benefit the environment, thereby moving an economy towards 'sustainable' development.

JEL Classification Numbers:
Q28, Q38

1/ This paper was initiated by Mr. Parry while he was a summer intern in the Fiscal Affairs Department.

2/ We are grateful to Ke-young Chu, Jonathan Levin, and David Nellor for helpful suggestions. Any errors are attributable to the authors.

Contents

Summary

The most commonly cited environmental instruments are intended primarily to address market failures by ensuring that economic agents take into account the social costs that arise as they pursue their goals. However, the underlying causes of environmental degradation are often rooted in policy failures rather than in market failures. In many countries, the policy failure that often lead to environmental degradation are linked to public expenditure policies.

This paper focuses on the implications of public expenditure policy for the environment and illustrates how countries can reform environmentally harmful subsidies, increase operations and maintenance expenditures for public investment projects, and incorporate the environmental aspects of projects into their cost-benefit analyses. Subsidy reduction that leads to expenditure savings would also allow a country to raise social expenditures and to establish or strengthen an appropriate safety net for the vulnerable population groups. In addressing environmental concerns, countries need to recognize that expenditure policies have a broad and important role to play.

I. Introduction

In recent years, increasing attention has been paid to the importance of proper management of natural resource bases and the environment in developed, centrally-planned, transition, and developing economies. Much of this attention has focussed on the choice of instruments available to a government in its efforts to ensure that environmental degradation and resource use is contained to appropriate levels, often defined in terms of marginal social costs and marginal social benefits. Increasingly, it is recognized that an integration of these instruments with the design of economic policies and stabilization and adjustment strategies is essential, if the objective is to move towards "sustainable" development.

While the most commonly cited instruments of environmental policy are intended primarily to address market failures, the underlying causes of environmental degradation are often, however, rooted not in market failures, but rather in policy failures. In many countries, the most common policy failure leading to adverse environmental implications are linked to public expenditure policies. Thus, subsidization of inputs which are already characterized by negative spillovers (e.g., chemical fertilizers, pesticides, energy), the underpricing (a form of implicit subsidization) of resources characterized by positive externalities (e.g., timber), insufficient outlays on operations and maintenance (O&M), and inadequate valuation of environmental costs in capital projects may indeed cause or aggravate environmental degradation.

Thus, an often underplayed instrument of environmental policy is expenditure policy. This paper focuses on the interactions between public expenditure policy and the environment, and illustrates how a reform of environmentally harmful subsidies, increased outlays on O&M, and proper quantification (or, at minimum, a qualitative assessment) of environmental costs in capital expenditures can reduce policy-induced environmental aggravation. In particular, this paper emphasizes that expenditure policies have an important role to play in addressing environmental concerns. Section II lays down the objective and instruments of an environmental policy from an economic perspective, and shows how the adoption of an environmentally-friendly expenditure policy is consistent with attaining this objective. Section III presents some data on the magnitudes of the subsidies involved for a number of different commodities across various countries and discusses their environmental consequences. In addition, it examines the effects of underfinancing of O&M expenditures and different types of capital expenditures on the environment. Section IV briefly alludes to the implications of an efficient environmental policy for poverty. Conclusions and policy implications are presented in Section V.

II. Environmental Policy: Objective and Instruments

1. Objective

The objective of environmental policy is to evaluate the social costs associated with environmental externalities, and then to utilize available policy instruments to create incentives for these costs to be reflected in resource allocation decision, such that marginal social costs equal marginal social benefits. In this way, damage to the environment is constrained to appropriate levels. 1/

This is illustrated in Figure 1. The intersection of the demand curve DD and the market supply curve SS generates an "equilibrium" price and output combination a. However, in this instance, the market fails to take into account the welfare costs (measured by area abc) imposed elsewhere by the use of resources in this fashion--these external costs imply that the supply curve should be S'S', resulting in an equilibrium b where price is higher and output lower compared to the case where external costs are ignored. The market, therefore, underprices and overuses resources. The objective of environmental policy is to create incentives to effect a move from an equilibrium like a to one like b to contain environmental damage and/or to limit natural resource use.

In some instances, provision of an implicit or explicit budgetary subsidy increases the output level to a level like q2, thereby worsening environmental degradation and the external costs borne by society. In this

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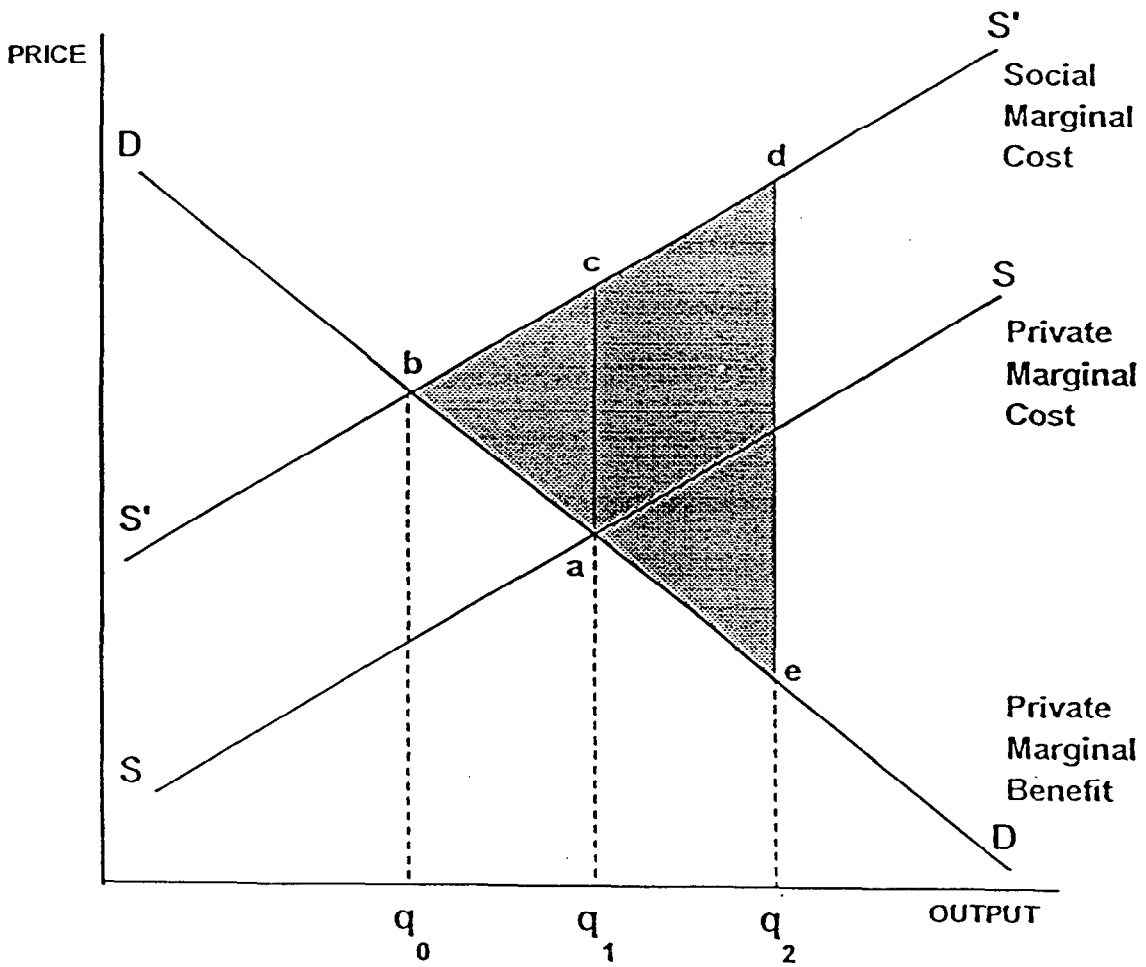
1/ Many ecologists and environmentalists argue that the degree of environmental degradation, as established from an economic perspective, may not necessarily guarantee the sustainability of the carrying capacity of the ecosystem. These views, which tend to place greater emphasis on the irreversibility and dynamic cumulative adverse implications of many economic activities, emphasize that an "ecological gap" is likely to emerge. This is because the "economically optimal" level of environmental degradation may exceed the "ecologically optimal" level, thereby setting in motion a dynamic process in which the carrying capacity of an ecosystem is systematically reduced through time, generating a "doom" solution.

Given the dynamic and intertemporal nature of many externalities, the choice of an "economically optimal" level is heavily influenced by the choice of the social discount rate. In addition, given the evolutionary nature of knowledge concerning environmental and ecological precesses, the "ecologically optimal" level of environmental degradation is subject to a great deal of uncertainty (in the form of an incomplete and imperfect information set). It seems, thus, that among ecologists, environmentalists, and economists, a consensus on the choice of the "optimal" level is unlikely to emerge. For a more detailed discussion on the optimal level of environmental degradation, the assimilative capacity of the environment, and sustainability, see Pearce (1976), Tisdell (1988), Daly (1987), and Pezzey (1989).

Figure 1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instance, the welfare cost bde is larger than would be the case without (implicit or explicit) budgetary subsidization. Clearly, as part of an overall strategy to reduce environmental degradation and to strengthen macroeconomic balances, such policy failures should be corrected. 1/

2. Instruments

The commonly cited environmental instruments available to governments have been broadly classified as (i) those falling under the domain of the regulatory and legal framework; (2) moral suasion; and (3) fiscal measures. 2/ A common feature of these instruments is that they are designed to address particular market failures (such as externalities, ill-defined or absent property rights, underpriced or unpriced resources, absent or thin markets, excessively high transaction costs which discourage otherwise beneficial exchanges, the existence of public goods, lack of information, myopia, and excessive risk aversion), through either direct or market-oriented mechanisms. The instruments are thus intended to ensure that economic agents take into account the social costs associated with externalities that may arise in the pursuit of their pecuniary ends; these instruments seek to create incentives to "internalize" the external costs of an activity.

However, as noted earlier, in many instances it is a policy failure, often reflected in public expenditure decisions, that may contribute to environmental degradation. Thus, a removal of subsidies for outputs and inputs with negative spillovers, increased allocations for O&M, and thorough assessments of the environmental impacts of certain types of capital expenditures are some of the other instruments available to ensure that marginal social costs do not exceed marginal social benefits.

1/ While the underlying distortion should also be corrected, this paper focuses on policy-induced aggravation(s) of pre-existing distortions. This focus reflects the fact that, in many instances, a greater welfare gain will come about by "correcting" a policy failure which aggravates a pre-existing distortion, than by correcting the existing market failure (that is, in Figure 1, area caed can in many instances exceed area bca). In addition, in many instances it is less costly to remove a policy distortion than to address the underlying externality.

2/ Annex Table 8 summarizes some of the key characteristics and appropriate uses of these instruments and provides some examples of their implementation. The table also categorizes these instruments according to another common classificatory scheme for environmental instruments: direct control (also called command-and-control (CAC)) versus market-oriented.

3. Interaction with macropolicy instruments 1/

The use of subsidy reform as an instrument of environmental policy can have significant effects on both short-run and long-run macroeconomic balances and performance. As subsidy reform proceeds, certain macroeconomic balances may improve, while others deteriorate. At the same time, the short-run macroeconomic implications of subsidy reform may differ from the long-run effects. For example, a reduction in energy subsidies can improve the fiscal balance of a country, 2/ through reduced outlays or decreased "negative taxation"; be a spur to more efficient energy use in the economy; and, because of reduced domestic consumption of energy resources, result in a better balance of payments position in both the short and long-run. In the short-run, however, output (national income) may decline, as certain firms become uneconomic and as other firms adjust their production techniques and levels to the new price of energy. Policies aimed at reducing the underpricing of forest resources 3/ (for example, through removal of tax concessions) will improve the fiscal balance, but may result in a deterioration of the balance of payments in the short-run. Over the longer-term, however, such a policy will aid the balance of payments, especially if forest resources are harvested on a more sustainable basis. In addition, such a policy would translate into increased efficiency in resource use, leading to a higher output level in the medium term. 4/ This section is intended to broadly illustrate some of the possible macroeconomic effects that subsidy reform can have on national output; the fiscal balance; and the balance of payments. While the discussion is of a general nature, it is nonetheless intended to provide a broad picture of some of the potential macroeconomic consequences that reform of environmentally unfriendly subsidies would entail.

1/ This section focuses on subsidy reform, although it is also applicable to other public expenditure reform measures (e.g. increased O&M expenditures) aimed at addressing environmental concerns.

2/ Many of the subsidies discussed in this paper are commonly effected through a public enterprise, including through the central bank via a preferential exchange rate. Because of this, the fiscal balance should be interpreted as pertaining to the overall public sector, thereby including these quasi-fiscal operations.

3/ The underpricing of forest resources typically involves the granting of concessions which, in combination with improvement fees, are below true scarcity values. Under such circumstances, an implicit subsidy exists -- part (or all) of which may be clawed back through export taxes. Explicit subsidies may come about through the granting of tax benefits.

4/ True sustainability would require that the positive external benefits of standing forests be incorporated into decisions on the level of annual harvest. Nonetheless, efforts to reduce overexploitation through reductions of explicit or implicit subsidies will place production on a relatively more sustainable basis.

a. Balance of payments

The reform of environment-related subsidy policy can have important balance of payments implications. Reductions in energy subsidies (on petroleum products for automobiles and trucks, kerosene for cooking and lighting, and electricity) can reduce import requirements or, if the country is a producer, allow higher exports. 1/ In the case of pesticides and chemical fertilizers, a reduction in subsidies can lead to lower import requirements of the products themselves, or of imported inputs for their production. However, any short-run reduction in agricultural output resulting from such a reduction of subsidies may necessitate an increase in food imports. In the case of forest resources, as noted above, reductions in the explicit or implicit subsidies are likely to have an adverse short-run balance of payments effect; however, over the longer-run, an improvement is likely to result as harvests are brought closer to sustainable levels. In countries facing power shortages, reductions in electricity subsidies, particularly to the rural sector, will not only lead to a better use of electricity in the farming sector, but will also increase the availability of power for other sectors of the economy. The latter will tend to increase domestic production, thereby reducing imports and/or increasing exports.

b. National output

Reform of environment-impinging subsidies can have significant effects on national output, as the following two examples help to illustrate. In the agricultural sector, a reduction of subsidies to chemical fertilizers may reduce per hectare yields in the short-run. However, over the medium and long-term, parts of these losses may be recouped, as soil structure and hence soil productivity improve with the application of organic fertilizer. 2/ At the same time, although agricultural output may decline, this may also be partially compensated by increases in the value of production in sectors of the economy previously damaged by chemical fertilizers applications. Most of the external effects of excessive fertilizer applications are, however, felt in the nonmarketed economy. Thus, chemical fertilizers may contaminate ground and surface water, as well

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1/ It is often argued that a reduction of kerosene subsidies may force poorer groups to switch to wood for cooking. However, according to the evidence presented later in this paper, the elasticity of substitution between firewood and kerosene is very small.

2/ Although farmers should be able to see ex ante that the practices they follow in the short-run will hurt them over the long-run, and thus should internalize the externality themselves by reducing fertilizer applications, many factors militate against this, including imperfect information, imperfect credit markets (resulting in a higher private discount rate), and insecure property rights. Even if farmers were to internalize the externality which affects their own future productivity, fertilizer application may still be excessive, because farmers do not bear the off-farm external costs associated with fertilizers.

as cause air pollution. In such instances, national welfare may improve, even though there is no measured marketable offset to the loss of measured agricultural output. 1/

In the case of pesticides, a reduction in subsidy levels is likely to have a much smaller effect on agricultural production, because such subsidies tend primarily to encourage an excessive application with minimal marginal benefits. The benefits tend to be marginal because farmers generally act independently of one another, and thus shift the burden of an insect infestation from their plot of land to another. For this reason, countries such as Indonesia, which have moved to reduce pesticide subsidies, have accompanied such policy actions with the adoption of Integrated Pest Management (IPM) systems. 2/ Over the longer-run, a reduction in subsidies to pesticides is likely to have important output consequences; because pesticide applications tend to increase the resistance of pests and to eliminate pest predators, the incidence of pest problems increases in the future. Thus, a systematic reduction of pesticide subsidies, when complemented by IPM schemes, can improve output over the medium-term. At the same time, the value of nonagricultural production may increase, as sectors of the economy previously hurt by pesticide residues expand. Furthermore, as with chemical fertilizers, many of the external costs associated with pesticide applications are felt in the nonmarketed economy (in the form of contaminated waterways and air pollution, for example). Again, a reduction of pesticides may lead to an improvement in national welfare, even without a corresponding increase in measured national output.

c. Fiscal balance

The reform of subsidies with harmful environmental effects can have important positive fiscal balance effects. As illustrated in Section IV, reductions of subsidies on chemical fertilizers, pesticides, energy, forest resources, etc., can substantially improve the fiscal balance of a country. While the reduction in government expenditures or decrease in "negative taxation" is a direct source of fiscal improvement, a secondary improvement can result from an expansion of the tax base as marketed activities which formerly bore the external costs expand. On the other hand, especially in the short-run, some revenue losses may be associated with any output losses that may occur in the transition to the new equilibrium. The latter two (secondary) effects are, however, likely to be small compared with the initial impact of the subsidy reduction.

1/ Indeed, measured output may actually fall: to the extent that chemical fertilizers (and pesticides (see below)) result in a degradation of human health, an output "loss" in the health sector as a result of improved health conditions may signify an improvement in welfare.

2/ Integrated Pest Management schemes control insect infestations through, among other things, more selective use of chemical pesticides, limiting applications to those periods during which pests are most vulnerable. See Repetto (1985).

III. Expenditure Policy and the Environment

This section reviews in greater detail how government subsidies can exacerbate environmental problems and examines the scope for using subsidy reform as a tool to positively benefit the environment. It is followed by a discussion on how insufficient O&M expenditures can damage the environment. Finally, issues relating to capital expenditure and the environment are taken up.

1. Environmentally unfriendly subsidies

If the output in a particular market is already socially excessive because environmental externalities are ignored by economic agents, the welfare costs of a government subsidy to this market become larger than if the subsidy were applied in a well-functioning market (Figure 1). In the following discussion, it is shown that activities within agriculture, energy, and forestry are likely to be characterized by such failure to fully internalize environmental costs, and the problems are frequently exacerbated by substantial government subsidies.

a. Agricultural subsidies

Both agricultural outputs and inputs have been a popular target of government subsidies.

Output subsidies. Agricultural production in OECD countries has been supported with the help of trade-barriers that have kept domestic prices high; total transfers from both tax payers and consumers to the agricultural sector in these countries amounted to US$300 billion in 1990. The transfers were in excess of 4 percent of GDP in Finland and Norway, and above 2 percent of GDP for the EC, Japan, and Switzerland (Kelley and McGuirk, (1992)). The justification for maintaining high prices and providing subsidies has tended to be more political than economic, e.g., to redistribute income in favor of farmers, particularly small farmers, and to obtain a certain supply of domestically-produced food for national security reasons, etc. 1/

There has been a growing concern over the environmental damage caused by subsidies that encourage higher agricultural production. 2/ Such subsidies are damaging because they increase the derived demand for

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1/ However, there is a growing recognition that, despite the price support given, the Common Agricultural Policy in the European Community has failed to ensure adequate income levels for small scale farmers, while producing windfall gains for large scale producers (Rosenblatt et. al, (1988)).

2/ See for example, OECD (1989); and World Commission on Environment and Development (1987).

agricultural inputs such as pesticides, fertilizers, and irrigation (which are themselves associated with external environmental costs) and because they provide incentives for land clearance which can result in loss of wildlife, forests, public amenities, soil erosion, etc. Even when accompanied by acreage controls, as in the United States and Japan, output subsidies can increase farming intensity which can, in turn, exacerbate problems of soil exhaustion.

Reducing such subsidies would be beneficial to the fiscal balance (Table 1), while simultaneously addressing some of the aforementioned environmental problems. However, while some estimates on possible improvements to the fiscal balance for selected countries are available, little work appears to have been done on estimating the welfare gains of improved environmental incentives. 1/

Input subsidies. Perhaps somewhat less visible than output subsidies are different types of subsidies for agricultural inputs. Such subsidies are common in developing countries, although industrial countries are not immune from them. In particular, subsidies for inputs such as pesticides, fertilizers, and irrigation water can be harmful to the environment. The environmental damage caused by the use of these agricultural inputs is likely to be greater if property rights for agricultural land are ill-defined--since farmers may lack incentives for adequate soil conservation and thereby overuse inputs which damage soil fertility. In this case, the environmental costs of input subsidies are even more serious. 2/

In many developing countries, input subsidies were initially justified during the "Green Revolution" of the 1960s, on the grounds that farmers would underestimate their benefits (and overestimate the risks involved) and therefore under-utilize them. Indeed, with such information asymmetries, there may well have been a case for such subsidies in these countries, but only on a transitional basis. Such "information" becomes common knowledge eventually, and thus today--i.e. more than 20 years later--subsidies in this form can hardly be justified on this basis.

1/ A reduction in such subsidies would also encourage a shift of resources from agriculture into manufacturing and services, with no clear effect on the balance of payments one way or the other. The resulting reallocation of resources is likely to raise real incomes. For instance, it has been estimated that real income in the EC would rise by 0.3 to 3.5 percent with the abolition of the Common Agricultural Policy (Rosenblatt, et al. (1988)). These estimates exclude possible benefits or losses that may accrue to the rest of the world, as well as any improvement in economic welfare that would result from reduced damage to environment.

2/ Secondary effects of the subsidies should also be borne in mind. Since agricultural inputs are likely to be complementary to irrigation subsidies, for example, this may indirectly aggravate environmental problems through increasing the use of fertilizers and pesticides.

Table 1. Budgetary Transfers
Associated with Agricultural Policies

(In billions of U.S. dollars)

	1986	1987	1988	1989	1990 Estimate
Total	115.5	120.4	122.5	118.3	124.5
Australia	0.4	0.3	0.2	0.3	0.3
Austria	0.4	1.0	1.0	0.8	1.1
Canada	4.4	5.6	5.7	4.3	4.7
EC-12	31.7	38.2	45.6	41.3	49.3
Finland	1.3	1.6	1.8	1.7	2.2
Japan	13.9	17.9	19.6	18.0	14.9
New Zealand	0.9	0.1	0.1	--	--
Norway	1.5	1.8	1.9	1.8	2.1
Sweden	0.5	0.6	0.6	0.5	0.5
Switzerland	1.1	1.7	1.8	1.8	2.3
United States	59.4	51.6	44.2	47.8	47.1

Source: Kelley and McGuirk (1992).

Other reasons have been advanced for subsidizing agricultural inputs. 1/ First, it is argued that, to the extent that agricultural output prices are held down by governments in many developing countries in order to keep basic food prices low, input subsidies are needed to prevent a significant fall in agricultural output. Clearly, however, there are more efficient means of protecting the poor (for example, through targeted subsidies on the consumption of agricultural products), than by directly holding prices down. A second justification for subsidizing agricultural

1/ For a discussion of the issues see Quibria (1987).

inputs is that poorly developed capital markets limit the ability of farmers to borrow to pay for expensive new techniques that include the use of inputs such as chemical fertilizers. Of course, to the extent this justifies intervention, it would be more efficient for the government to provide a general subsidy for investment, rather than making it conditional on the purchase of particular inputs. Finally, it is contended that input subsidies are beneficial from an equity point of view as they assist in redistributing income in favor of agricultural workers and small-scale farmers. In practice, however, input subsidies tend to be inequitable, benefitting better-off population groups who are in a position to buy larger quantities of the subsidized inputs.

In the ensuing discussion, the extent of subsidies on agricultural inputs, pesticides, fertilizers, and irrigation is highlighted. It is shown that these subsidies have serious environmental implications and can also result in heavy budgetary burden. Thus, their gradual reduction will have beneficial effects on both the environment and fiscal balance. 1/ However, it is possible that production of certain agricultural commodities that rely heavily on subsidized inputs may decline in the short run. Besides impinging on GDP growth, the resulting shortfall in agricultural output may have to be met through imports, especially if these commodities are deemed to be essential foodstuffs. This may, in turn, exert pressure on the balance of payments position of the country.

Chemical pesticides are used to reduce the incidence of crop damage caused by insect pests. However, this can lead to environmental costs and externalities in four different ways. First, the resistance of pests may increase. If, as has been found in numerous scientific studies, only the strongest pests survive, the average resistance of pests will rise through time. Second, pest predator insects may also be killed off by pesticides, thereby increasing the survival rate of remaining pests, and hence the incidence of pest problems in the future. With respect to these first two environmental costs, it should be borne in mind that individual farmers may not bear the full burden of these costs, and hence may not have adequate incentives to internalize them. Third, chemicals tend to pollute the air, waterway, and soils. Again, as these costs are not borne by the individual farmer, there may be incentives to overuse pesticides. Furthermore, this pollution may not be contained (localized) to its application site, since chemicals can travel long distances (via winds and waterways), particularly when sprayed from planes. Finally, there is a possibility of health damage to farm workers and consumers stemming from the use of these chemicals. These problems are typically aggravated by a lack of information as to the possible health consequences of prolonged exposure to the pesticides, on the part of both workers who must apply the pesticide as well as consumers who purchase the end-product.

1/ However, if the reduction in input subsidies is not accompanied by an adjustment of output prices or price controls are maintained, the overall fiscal position may not show any improvement.

It is not easy to quantify the welfare losses arising from pesticide subsidies because of difficulties in quantifying the environmental costs per unit of pesticide use; little is known about the elasticity of demand for pesticides, particularly in developing countries; and even the size of the government subsidy is unknown in many cases, since pesticides are typically subsidized in several different ways simultaneously.

Governments have provided both explicit and implicit subsidies for pesticides in a variety of ways (Table 2). The forms that these subsidies have taken include:

(1) Provision of pesticides to farmers at below-market prices. This had been the major form of pesticide subsidy in Indonesia, and it resulted in farmers paying only 20 percent of the retail cost of pesticides. 1/ In Senegal, government agencies provided 90 percent of pesticides free of charge.

(2) Provision of preferential foreign exchange rates for pesticides. This provided retailers in Colombia, Honduras, Ecuador, Ghana, and Egypt with considerable implicit subsidies for importing pesticides.

(3) Extension of subsidized credit for pesticide use from government-controlled agencies. 2/ Below-market credit resulted in a 70 percent subsidy in Ghana and 56 percent subsidy in Egypt.

(4) Provision of tax exemptions, which subsidize consumption of pesticides by exempting it from sales and consumption taxes and/or by reducing tariffs on pesticide imports.

As already noted, the size of the total pesticide subsidy, and hence the fiscal cost involved, is difficult to estimate, because subsidies have taken several different forms simultaneously. Nevertheless, Repetto (1985) has attempted an estimation for a number of countries. These estimates assume that pesticide importers paid average exchange rates, average import duties, and that pesticide purchasers paid average sales taxes and market interest rates.

1/ Beginning in the mid-1980s, the Indonesian government adopted an Integrated Pest Management scheme that curtailed the use of chemical pesticides. The scheme has resulted in a halving of pesticide use, and has saved the government about U.S.$120 million through 1990. Furthermore, crop yields have actually increased, because pest populations have been better controlled.

2/ The implicit subsidy in this case may be even greater if, as has been common in a number of countries, the government-controlled agency is lax in its credit recovery standards.

Table 2: Types of Pesticide Subsidies in Eight Selected Developing Countries in the 1980s

Country	Subsidized prices to farmers	Imports at favorable foreign exchange	Subsidized credit for pesticide use	Tax exemptions (tariffs and sales taxes)
Colombia		25% subsidy for pesticides		1 to 1.25% tariff on pesticides (average rate is 42%). Exempt from average 6% sales tax.
Honduras		30% subsidy for pesticides.	Government agencies very lenient on debt repayment for pesticide purchases.	Nominal tariff subsidy but effective rate is small. Exempt from average 6% sales tax.
Ecuador		47% subsidy for pesticides		1.25 effective tariff rate on pesticides (average is 53%). Exempt from 3% sales tax.
Ghana		50% implicit subsidy for pesticides	Pesticide importers receive credit at 9% (market rate is 22%).	Exempt from 20% sales tax.
Egypt	Government does all spraying, but recovers 20% of the cost of pesticides, applications, and marketing.	30% subsidy for pesticides	Agricultural loans charged 8 to 9% (market interest rate is 15%)	No import duties. Exempt from 5% consumption tax.
Senegal	90% of pesticides supplied free of charge by government agencies			Exempt from 20% sales tax.
Indonesia	80% subsidy for pesticides			Tariff and sales tax exemption for pesticides of minor significance, therefore effect is negligible.
China	Large subsidy. Nominal prices lower in 1984 than 1966 despite inflation			Sales tax of 3% (average is 10%).

Source: Repetto (1985) p. 19-27.

Table 3 summarizes Repetto's results. The average rate of subsidy, as a percentage of full retail costs, has varied between 19 percent (China) and 89 percent (Senegal), with a median rate of 44 percent (Colombia). Fiscal costs 1/ are highest in China (US$285 million or 18.7 percent of the fiscal deficit), followed by Egypt (US$207 million), and Indonesia (US$128 million). Moreover, such costs increased over time in some of the countries studied because of rising demand for pesticides. For example, in Indonesia 1,500 metric tons of subsidized pesticides were sold in 1974, 7,150 tons in 1979, and 15,000 tons in 1984 (Repetto (1985), p.19).

Chemical fertilizers have been of great benefit in raising soil productivity and hence output per hectare. However, fertilizer use is also likely to have important external environmental costs. For example, fertilizers may contaminate ground and surface water, as well as cause air pollution. Moreover, chemical fertilizers are less efficient at preserving soil structure, compared with organic fertilizers, and can result in a depletion of future soil productivity. 2/

Subsidies are partly responsible for the rapid increase in the use of chemical fertilizers witnessed in many developing countries over the last 20 years. Table 4 shows the increase in consumption of all fertilizers in seven developing countries from 1976 to 1987. The percentage increase during this period ranges from 77 percent in Afghanistan to 360 percent in Indonesia. In many countries, a large part of the increase in chemical fertilizer use can be explained by the provision of government subsidies. While these subsidies are justified on various grounds (income redistribution, food security, etc. whose validity raises many of the same questions) they can nonetheless aggravate environmental problems.

Table 5 indicates the value of explicit fertilizer subsidies in several selected countries during the 1980s. It shows that government subsidies for fertilizer consumption are substantial in many countries. Furthermore, subsidies were extensive in all countries, e.g., in India the fiscal burden of fertilizer subsidies remained over 3 percent of total government expenditure after 1983.

Governments, either directly or through parastatals, are often involved in the supply of surface irrigation water. Irrigation has been of great benefit to agriculture, through the extension of the supply of water to previously arid lands and through smoothing the availability of water throughout the year. Despite the large benefits associated with irrigation

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1/ It should be noted that these costs include direct budgetary costs as well as the costs borne by public enterprises and the central bank (i.e., quasi-fiscal costs).

2/ With well-established property rights for land, full information, and an appropriate discount rate on future income, farmers would take this into account.

Table 3: Size of Pesticide Subsidies 1/

Country	Estimated rate of subsidy as a percentage of full retail costs	Value of subsidy (US$ million)	Estimated subsidy as a percentage of government spending	Estimated subsidy as a percentage of budget deficit
Senegal	89	4	0.6	2.6
Egypt	83	207	1.2	4.1
Ghana	67	20	0.6	1.1
Honduras	29	12	...	...
Colombia	44	69	1.2	4.1
Ecuador	41	14	0.7	2.5
Indonesia	82	128	0.6	6.3
China	19	285	0.5	18.7

Sources: Repetto (1985), International Financial Statistics, and staff estimates.

1/ Estimates are for 1985.

Table 4. Percentage Increase in Total Fertilizer Consumption for Selected Countries, 1976-1987

Country	Percentage increase
Afghanistan	77
Bangladesh	191
India	165
Indonesia	360
Iran	186
Pakistan	173
Venezuela	280

Source: FAO Fertilizer Yearbook, various issues.

Table 5. Fertilizer Subsidies in Selected Countries

(US$ millions)

Country	1982/83	1983/84	1984/85	1985/86	1986/87
	(Figures in parentheses are percentages of government spending)				
Bangladesh	38.4 (2.5)	57.9 (4.4)	33.4 (2.2)	12.8 (0.7)	13.4(...)
India	581.7 (2.3)	891.2 (3.1)	1,056.1 (3.4)	1,293.6 (3.7)	1,501.0(3.6)
Indonesia	491.4 (2.3)	324.2 (1.8)	684.7 (3.9)	402.6 (2.1)	364.3(2.0)
Pakistan	164.4 (3.5)	147.2 (2.7)	106.8 (1.8)	151.2 (2.6)	77.1(1.1)
Poland	... (...)	264.3 (...)	299.4 (...)	321.5 (...)	439.3(1.4)
Venezuela	... (...)	... (...)	58.6 (0.5)	124.3 (1.0)	160.1 (...)

Sources: FAO Fertilizer Yearbook; International Financial Statistics; and staff estimates.

systems, these systems are also associated with externalities, arising from both their construction (i.e., building dams and canals), operation (salinization and waterlogging of farmland), and from inadequate provisions of operations and maintenance expenditure on the canal system.

Irrigation subsidies exacerbate environmental problems by encouraging excessive outlays on irrigation projects and indirectly directing resources away from O&M. Clearly, substantial consumption subsidies create excess demand for water by farmers. This, coupled with the fact that taxpayers, rather than irrigation users, bear the risks associated with projects, results in intensive pressure for expanding capacity beyond what

would be justified on economic grounds. 1/ Irrigation subsidies can also harm the environment directly by encouraging wasteful use of water by farmers, thereby increasing the likelihood of waterlogging.

Users of public irrigation systems worldwide receive a substantial (implicit) subsidy since user charges, if levied at all, typically fall short of operation and maintenance costs (O&M), let alone allowing recovery of capital costs. For the six selected developing countries shown in Annex Table 9, revenues generated from irrigation charges do not cover O&M costs in five of the countries and are substantially below total costs in all six countries. This is partly because either the charges have been kept low or have simply not been collected. 2/ In many developing countries, the problem of low cost recovery has been compounded by weak administrative machinery.

Evidence presented by Repetto (1986) shows that cost recovery has generally been inadequate both in developing and industrial countries. Using a moderate estimate of capital costs, actual revenues from user charges as a percent of total costs have varied from a low of 0.9 percent in Bangladesh to 18.9 percent in the Philippines (Annex Table 9). Annex Table 10 shows the estimated full costs of irrigation supply and user charges for different irrigation districts in the United States indicating that such subsidies are not limited to developing countries. User charges as a percent of full costs in 1985 ranged from 53.8 percent in Oroville-Tonasket to just 3.8 percent in Grand Valley.

b. Energy subsidies

Most countries encourage the consumption and/or production of energy, by providing implicit or explicit subsidies for coal, electricity, gas, and nuclear power. Also, oil consumption is typically subsidized in oil-exporting countries. Yet energy use is responsible for many of the world's most serious environmental problems including:

1/ For evidence of numerous uneconomic irrigation projects undertaken in selected countries, see Repetto (1986).

2/ It should, however, be recognized that cost recovery may in fact take place indirectly, through the collection of export and other taxes on agricultural production. Nonetheless, this form of implicit user fee may be inefficient, because it fails to link usage and benefits.

(1) Possible global warming resulting from the build-up of greenhouse gases in the atmosphere. Carbon dioxide, which results from the burning of fossil fuels, is the major contributor to the greenhouse effect; 1/

(2) Damage to property, forests, livestock, aquatic life, etc. caused by acid rain (which results when secondary pollutants discharged during the combustion of fossil fuels combine with water molecules in the air) and primary pollutants such as dust, soot, and ash which are caused by the incomplete combustion of fossil fuels;

(3) Health problems, in particular respiratory diseases caused by inhaling air containing pollutants such as sulfur dioxide, nitrogen oxide, carbon monoxide, hydrocarbons, etc.;

(4) Safety risks associated with the production of nuclear energy and the disposal of nuclear waste.

Particular energy subsidies tend to have their own specific justifications. Oftentimes, however, these are of debatable empirical relevance. For example, it is argued that kerosene subsidies in developing countries (i) are equitable since they benefit poor families; and (ii) reduce the problem of deforestation, since people rely more on kerosene for fuel, rather than on firewood. Pitt (1983), however, found that kerosene subsidies in Indonesia disproportionately benefit better-off households and that the elasticity of substitution between firewood and kerosene was very small. Empirical evidence (Hughes (1985, 1987)) from Thailand further indicates that between 1975 and 1982 there was a tendency to substitute away from relatively expensive petroleum products in favor of subsidized kerosene, making the subsidy untargeted.

Shah and Larsen (1992) have estimated that total world energy subsidies exceeded US$ 230 billion in 1990. In revenue terms, these were equivalent to an average "negative" carbon tax of US$ 40 per ton of carbon. The size of these subsidies was particularly large in a handful of countries. According to Shah and Larsen, an elimination of these subsidies could reduce global carbon emissions by 9.5 percent and translate into a 21 percent reduction in carbon emissions in the subsidizing countries.

Tables 6 and 7 provide further information on the extent of energy subsidies. In most countries electricity prices appear to fall far short of long run marginal costs, thereby creating significant subsidies for electricity consumption. Table 6, based on a study by Kosmo (1987), shows

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1/ According to Schelling (1992), the populations of developing countries are more vulnerable to the effects of warming from carbon dioxide and other greenhouse gases, because a much larger proportion of GDP originates in agriculture and forestry in developing countries. Further, risks in developing countries of disease associated with higher temperatures would increase with a warming of the climate.

that the price/long run marginal cost ratio is less than one in all of the 12 selected countries and as low as 0.15 in Uganda. Table 7 shows prices for selected petroleum products for the major oil-exporting countries in mid-1990 and mid-1991. In 1991, prices for gasoline averaged between 21 and 25 cents a liter, while those for automotive diesel were 16 cents a liter. These prices are substantially lower than those prevailing in OECD countries, even if the cost of transporting petroleum from producing countries is accounted for, indicating that extensive implicit energy subsidies are provided to consumers in oil-exporting countries.

c. Subsidies for timber exploitation

Trees are harvested primarily for two types of economic activity: selling timber, either directly or after processing; and to clear land for certain projects such as farms, highways, urban settlements, etc. 1/ The resulting deforestation 2/ can result in both local and global environmental degradation. In particular, timber exploitation can lead to soil erosion, since soils are no longer protected against wind and rain by trees (including branches and roots). Besides leaving the once-forested area infertile, this can also cause sedimentation in waterways (and thus potential flooding) and damage to land by deposits. In Thailand, for example, the contraction of teak forests caused soils to swamp local villages in 1985, killing several hundred people and destroying farmland. Second, there can be damage to the trees not felled as they have less protection against wind and rain. Third, an increased fire hazard may result from the deadwood left behind. In 1983, for example, Kalimantan (Indonesia) was hit by a forest fire which affected an area the size of Belgium, the most damage being done in logged areas. Virgin forests were not significantly affected. Fourth, timber exploitation can lead to destruction of wildlife and even the extinction of certain species. Fifth, timber exploitation can destroy forest plants and undergrowth which cannot survive without the protection of the trees, but which may have potential economic value, e.g., tropical plants are used in the production of 25 percent of all prescription drugs in the United States. Sixth, timber exploitation can lead to global warming, both because forests act as "carbon sinks" (thereby limiting the build up of carbon dioxide, a greenhouse gas, in the atmosphere) and because the burning or decomposition of trees releases carbon into the atmosphere. It is estimated that 13 percent of the potential greenhouse effect is due to deforestation alone. 3/

1/ Many countries have changed their practices, and require logging companies to replant logged areas. Nonetheless, during the period during which the replanted trees are growing, transitional environmental problems may persist.

2/ In some developing countries, trees are also cut for use as fuelwood.

3/ See, for example, Flavin (1989).

Table 6: Electricity Subsidies in Selected Countries

Country	Year	Average revenues (¢/kW/h)	LRMC (¢/kW/h)	Price/LRMC
Bangladesh	(1984)	5.94	9.09	0.65
Bolivia	(1982)	3.70	5.85	0.63
China	(1984)	3.29	5.65	0.58
Ethiopia	(1983)	6.01	18.78	0.32
India	(1981)	3.70	7.00	0.52
Morocco	(1983)	8.00	12.70	0.63
Paraguay	(1982)	4.00	5.00	0.80
Peru	(1983)	5.36	8.40	0.45
Senegal	(1981)	11.70	12.72	0.82
Tanzania	(1983)	7.79	8.20	0.95
Uganda	(1982)	1.20	8.00	0.15

Source: Kosmo (1987).

Table 7. Prices for Petroleum Products in Oil-Exporting Countries 1/ 2/
(U.S. cents per liter)

Country	Year	Premium gasoline	Regular gasoline	Kerosene	Automotive diesel	Heavy fuel oil
Average	(1990)	32	28	17	21	4
	(1991)	25	21	13	16	7
Algeria	(1990)	42	35	...	11	...
	(1991)	21	17	...	4	...
Angola	(1990)	7	...	1	1	1
	(1991)	9	...	3	4	1
Bahrain	(1990)	27	21	7	19	...
	(1991)	27	21	7	19	...
Cameroon	(1990)	106	101	46	63	...
	(1991)	64	...	30	54	...
Congo	(1990)	111	...	64	73	...
	(1991)	...	...	...	...	...
Ecuador	(1990)	8	5	2	10	8
	(1991)	10	6	1	10	8
Indonesia	(1990)	23	...	10	12	11
	(1991)	30	...	12	16	12
Iran	(1990)	4	3	0.3	1	0.4
	(1991)	5	4	0.3	1	0.2
Kuwait	(1990)	...	...	...	...	...
	(1991)	33	26	27	26	27
Libya	(1990)	42	23	14	26	4
	(1991)	49	23	14	26	4
Malaysia	(1990)	40	37	23	21	...
	(1991)	40	38	25	23	...
Mexico	(1990)	...	...	...	...	...
	(1991)	...	25	...	20	...
Nigeria	(1990)	7	...	5	7	5
	(1991)	7	...	5	6	5
Oman	(1990)	31	29	30	...	...
	(1991)	31	29	30	...	...
Qatar	(1990)	16	15	...	...	...
	(1991)	16	15	...	...	...
Saudi Arabia	(1990)	14	...	8	3	2
	(1991)	14	...	8	3	2
Trinidad and Tobago	(1990)	31	30	19	19	...
	(1991)	35	34	21	21	...
United Arab Emirates	(1990)	27	25	...	23	...
	(1991)	27	25	...	23	...
Venezuela	(1990)	6	6	...	...	...
	(1991)	7	7	3	4	4
Memorandum item:						
OECD Average:	(1990)	78	71	35	49	15
	(1991)	79	71	37	49	14

Source: OECD, Energy Prices and Taxes; data provided by the authorities; and staff estimates.

1/ Mid-year data.

2/ The absolute dollar price may be distorted because of the over- or under-valuation of exchange rates used in converting domestic prices into dollar price.

In practice, rather than discouraging deforestation, governments often contribute to it by providing a range of direct and indirect subsidies (or tax expenditures) for the forestry sector. Repetto (1988) studied Indonesia, Malaysia, Philippines, China, Brazil, West Africa, and the United States. In each case, he found that governments were implicitly or explicitly subsidizing deforestation. Subsidies were granted in the hope of promoting two main objectives:

One major objective was to increase timber exports and/or to promote the domestic wood processing industry (also primarily for export). Annex Table 11 shows how log harvesting in Indonesia responded strongly to government concessions (including income tax holidays) to timber companies adopted in 1967. By the mid-1970's the annual average harvest of timber had increased eight-fold, compared with the average for the early 1960's. Removal of such concessions would reduce environmental damage and improve the fiscal balance, but at the potential cost of harming the balance of payments in the short run. Annex Table 12 indicates that both Indonesia and the Philippines sacrificed large sums of potential revenues, as a result of concessions to timber production. Actual logging rents (i.e., extranormal revenues) as a percentage of government spending in 1979-1982 were 6 percent in both countries, yet only 16.5 percent of this was captured by the Philippine government while 37.3 percent was captured by the Indonesian government.

The second objective was to clear forests for projects, including projects to encourage people to leave urban areas or to foster development in outlying regions. Most of the deforestation of the Amazon region in Brazil over the last twenty years appears to have been a direct result of government subsidy programs for development of the region, particularly for cattle ranching. The major subsidy programs included:

(1) Subsidized credit for investments in agriculture and livestock projects, aimed at stimulating regional development. The interest rate on these loans was fixed at 12 percent, which, as Annex Table 13 shows, was far below the market rate. Furthermore, given the grace period of six years, the effective interest rate was closer to 5 percent;

(2) Support from the Superintendency for the Development of the Amazon (SUDAM), which was set up in 1966 to encourage projects such as ranching and wood processing. For investors, capital outlays could be deducted from their income tax liabilities up to a maximum of 50 percent of such liabilities (in effect a subsidy for investment); income tax holidays of 15 years were granted on income from modernization, diversification and expansion; in addition, losses sustained in any particular year could be offset against other income for tax purposes. Finally, the government constructed and maintained free of charge infrastructure facilities such as roads. It is estimated that US$ 6.2 billion will have been spent by 1990 (see Repetto (1988)). As a result cattle ranching expanded rapidly, accounting for 72 percent of all deforestation in the Brazilian Amazon up to 1980 (Repetto (1988));

(3) Small farmer settlement policies of which there were two major programs. The first, the National Integration program (started in 1970)

aimed at settling 100,000 families in the Amazon region. As a result of this program, two highways, the Transamazon and the Cuiaba-Samtarem, were built. In the event, the project failed because of the difficulty of keeping the Transamazon highway open during the rainy season. With less than 13,000 families settled, the total cost per person settled was estimated at US$ 39,000, and 64,000 hectares of forest were destroyed in the process; the second, the North West Brazil Integrated Development Program (started in 1981) constructed the Cuiaba-Porta Velho highway at a cost of US$ 570 million.

2. Environmentally friendly subsidies

Until now, the discussion has focused on the adverse consequences of subsidy policies on the environment. However, there are many cases where government subsidies may positively benefit the environment. For instance, there are subsidies that promote activities which are beneficial to the environment or which are less damaging than alternative activities (assuming these environmental effects fail to be internalized by private agents). The former include subsidies for reforestation projects, farming techniques or crops which raise soil fertility. The latter includes subsidies for solar power plants, windmill farms (since they do not cause the air pollution associated with the burning of fossil fuels), and house insulation (since it reduces fuel consumption). There are also subsidies aimed at stimulating research and development into environmental issues and more environmentally-friendly technology. Government grants for research into the greenhouse effect, or the scope for using more solar and wind power, for example, are common, especially in the industrial countries. Lastly, subsidies can be aimed at promoting recycling. Such efforts would benefit the environment directly through reducing the amount of waste that needs to be disposed of, and indirectly by reducing the amount of processing (and hence energy use) required to produce final products.

However, there are certain caveats for using subsidies to prevent environmental degradation. First, subsidies will tend to be ineffective if the elasticity of substitution between the favored activity and other alternatives is low. For example, there is some evidence (Button (1990)) that reducing the price of public transport may have little impact on car traffic in the UK; and that government grants tend to crowd out private spending on research. Second, the private market on its own may be prepared to adopt an altruistic attitude towards the environment. For example, people may be willing to pay extra for ozone friendly aerosol sprays, for tuna fish which does not endanger dolphin species or, to convert their car engines for lead-free gasoline. Thirdly, subsidies or tax reliefs granted for environmental purposes may be difficult to remove in the future, because they create special interest groups. This could also lead to subsidies being granted to more vocal political groups rather than those who engage in the truly most environmentally-friendly activities. Lastly, such subsidies may encourage the expansion of inefficient production processes. Whether the environmental gains of such a subsidy would outweigh these losses over a period of time is not clear.

3. Operations and maintenance expenditure and the environment

Once capital construction has been completed on a public investment project, expenditures on O&M are required to preserve the flow of benefits of the project. Failure to provide adequate O&M not only reduces the efficiency of the initial capital investments, but may also result in adverse environmental consequences. The following discussion illustrates how inadequate O&M can interact with the environment.

Inadequate O&M on surface irrigation canals can lead to waterlogging and salinization of farmland, owing to excessive seepage from canals. India has lost 10 million hectares of land due to waterlogging and potentially another 25 million hectares to salinization. Worldwide it is estimated that agricultural productivity has been adversely affected by salinization of 50 percent of irrigated land. 1/ Insufficient O&M can also lead to blocking of canals due to siltation which exacerbates waterlogging and reduces water supplies to farms further down the canals.

Reducing outlays on road maintenance increases the fuel required to travel along the road at any given speed. Whether this actually increases or reduces the overall use of fuel is not absolutely clear since, on the one hand, more fuel is required per mile-hour, but, on the other hand, there will be a substitution away from road use as the costs rise relative to other transport modes. To the extent that road travel is a normal good, road traffic will fall. However, even if total fuel consumption (and hence air pollution) is reduced, it does not imply that underfinancing of road maintenance is efficient since there are better methods of protecting environment, e.g., through gasoline taxes.

4. Capital expenditure and the environment

Typically, governments undertake a wide range of investment programs. Ideally environmental aspects of a project should be incorporated into cost-benefit analysis when deciding among projects and their respective scale of operation. However, the monetary valuation of many environmental benefits and costs is difficult. For example, it is difficult to assign a monetary loss caused by the extinction of animal or bird species following deforestation. In view of the complexities involved, the effects on environment are often not fully incorporated in project decisions, thereby leading to long-term environmental problems. The effects of some types of capital expenditures on the environment are discussed below.

Irrigation projects require the construction of dams to create reservoirs and a network of surface water channels to distribute water supplies to farmers, both of which can have environmental effects. Reservoirs in many cases require the flooding of cropland, forests, and villages. The effects of such flooding should be clearly evaluated during project appraisal. Further, diversion of water may affect marine life and cause soils to lose their fertility. Also, there have been cases where ports have silted up because of a loss of water to flush out sediments.

1/ See Repetto (1986).

Again such costs should be fully taken into account when deciding how much water to divert.

The construction of distribution canals can lead to the erosion of valuable soils and, if not properly insulated, to waterlogging. Thus, planning a canal network requires careful study of how porous the land is, in order to judge how many channels should be constructed and their depth, as well as the need for lining the canals to prevent leakages. Canals can also exacerbate other environmental problems since they help transport residual chemicals from fertilizers and pesticides, and provide breeding grounds for agricultural pests and habitat for carriers of various diseases such as malaria.

The construction of roads can create environmental degradation in a variety of direct and indirect ways. Government construction of roads into forested areas can exacerbate the problem of deforestation. The costs of logging are reduced since loggers can use roads free of charge. Similarly road construction can stimulate the domestic wood processing industry by providing more access to markets. Also, deforestation for land settlement is subsidized if governments construct highways linking up these sites to urban areas. Where possible, such secondary effects of road investments need to be included in project appraisal. In addition, the desirability of including road construction costs in the charges for logging leases and royalties, as well as the potential for charging tolls to road users, should be assessed. In the absence of such tolls, road construction may also indirectly affect the environment. Increased vehicle mileage can exacerbate environmental problems by adding to air pollution and the discharge of more carbon dioxide into the atmosphere.

IV. Implications of Environmental Policy for Poverty

From the preceding analysis, two implications emerge for the poor. First, there is a trade-off between the protection of environment and the interests of the poor. Input subsidies that keep prices for basic food items low have been found to be harmful to the environment. Furthermore, what ever little income benefit that accrues to the poor from input subsidies is likely to be more than offset by the resulting degradation of the environment. Secondly, a correction of distortions in public expenditure policy, such as reducing subsidies on activities that are unfriendly to the environment, can raise economic welfare. Depending on their initial level and budgetary allocation desired for environmentally friendly subsidies, a net reduction in the subsidy bill is likely, contributing to a strengthening of the overall budgetary position. Unless there are constraints imposed by the macro situation, this budgetary improvement would create room for increasing expenditures on social sectors, including education and health, targeted to the extent feasible to the poorer segments of the population. The expenditure savings may also permit setting up or strengthening of an appropriately designed social safety net to facilitate income transfers to the vulnerable population groups. The establishment of social safety net is especially relevant in countries where a program of structural adjustment is underway and the associated realignment of prices and income reduction in some sectors imposes a heavy burden on certain segments of the population in the short-term.

V. Conclusions and Policy Implications

The foregoing discussion illustrates how subsidization of different inputs such as pesticides, chemical fertilizers, and energy as well as output subsidies and the underpricing of resources can have adverse environmental implications. It also shows that insufficient provision of O&M and improper valuation of environmental costs and benefits in different investment projects can impact negatively on the environment. Thus, one plausible way of addressing environmental concerns is to seek removal of distortions in public expenditure policy. Besides improving economic welfare, this can impact favorably on macro balances and macroeconomic performance, especially over the long-run.

Various steps can be initiated by policy makers to implement an environment-friendly expenditure policy. First, on the output side, subsidies that encourage more than socially desirable production or consumption can be phased out. Second, the experience has shown that the nature and extent of input subsidies has been varied, ranging from provision of below market exchange rates for imports, to subsidized credit, to keeping market prices for inputs below market clearing levels. Many of these subsidies cannot be justified on economic grounds particularly over longer periods of time. In view of their environmental implications as well as the fiscal (or quasi-fiscal) burden that they impose, it is necessary to examine afresh the underlying rationale for them. A careful analysis may suggest that these subsidies can be eliminated. Nonetheless, while doing so, care would have to be taken to ensure that the external balance is not too adversely affected on a net basis in the short term by the subsidy reduction or withdrawal. This can happen when output of commodities benefitting from subsidies falls and the resulting foreign exchange savings from the reduced input imports is less than the foreign exchange expended on imports to cover the domestic shortages. 1/ However, this consideration may not be relevant if external financing is available. Third, provision of adequate O&M is required not only to sustain the productivity of existing projects, but also to avoid adverse effects on the environment. Fourthly, environmental aspects--quantitatively or at least qualitatively--should be taken into consideration when choosing among projects and their scale of operation. This is necessary because of the irreversibility of capital expenditures and potentially high cost of mitigating environmental damage once the project comes on stream. Lastly, possible expenditure savings arising from subsidy reduction would create room for raising social expenditures, and for establishing or strengthening of an appropriate social safety net for vulnerable population groups.

1/ The improvement in fiscal balance would also have a favorable impact on the balance of payments. Thus, the effect on external balance has to be netted across all these considerations.

Table 8: Environmental Instruments

Instrument	General remarks	Examples	Market/direct control
1. *Regulatory and Legal Framework*			
a. Regulation	- Useful in situations where metering of pollution is not possible; - may invoke specification of acceptable techniques of production; - may involve the setting of pollution standards (including the prohibition of particularly hazardous activities).	- Requirements to equip cars with catalytic converters; - requirements to install pollution reducing devices, such as smokestack scrubbers; - standards; - prohibition of activities that may be extremely dangerous; - resource use quotas and harvesting quotas (e.g., fisheries).	Direct control.
b. Legal Framework: Property Rights	- Useful when a particular environmental problem derives from the ill-definition or lack of property rights; - requires a legal system which can adjudicate property rights disputes and establish legal liability; - property rights must be well-defined, exclusive, secure, transferable, and enforceable, if system is to function efficiently; - the efficacy of such an approach depends on, among other things, the enforceability of the rights themselves and the transactions costs associated with civil litigation.	- Land titling; - allocation of pollution rights; - liability insurance legislation.	Though established by government, applied primarily as a market mechanism. Once property rights are clearly established, these rights can be traded in the private market place.

Instrument	General remarks	Examples	Market/direct control
2. Moral Suasion	- Useful during short-term emergency periods; - appropriate where effective monitoring of regulations is difficult.	- forest-fire prevention; - littering in national parks. - During high smog days, appeals to reduce unnecessary driving;	Direct "control".
3. Fiscal Measures			
a. Subsidies and Grants	- Aimed at compensating those who voluntarily reduce the amount of pollution they generate; - used as incentives for encouraging certain types of activities; - useful when monitoring and/or metering are feasible.	- Subsidies (generally in the form of tax breaks) for the installation of solar generation capacity or for the planting of trees as windbreaks against soil erosion; - grants to install equipment to control pollution.	Market-oriented.
b. Taxes and Fees	- Generally requires fairly precise metering of individual polluters; - taxes and fees should be set at level that reduces emissions to optimal amounts, not at revenue-maximizing levels; - should be tailored to the circumstances and/or locality in which it is being implemented; - fiscal control of the revenues may be disputed (earmarking).	- Effluent charges; - emission charges; - user fees (fishing and logging permits).	Market-oriented.
c. Pollution Permits	- Fiscal implications, if auctioned or sold; - convey the right to pollute up to some agreed maximum level; - metering of individual polluters is required.	- Auctioning of pollution permits.	Market-oriented, so long as permits are tradeable.

Instrument	General remarks	Examples	Market/direct control
d. Refundable Deposits	- When metering is possible, but for technical reasons is difficult, refundable deposits shift the burden of proof about pollution to the claimant; - provides incentives to return pollutants for recycling.	- Refundable deposits on beverage containers.	Market-oriented.
e. Government Investment Activities	- Relevant where the (environmental) public goods characteristics of investments and/or scale economies make private investment unlikely; - also important where external benefits (or costs) cannot be adequately captured (or borne) by private agents.	- Water purifications plants; - sewerage systems.	Direct control.

Sources: Barmol and Oates (1979).

Table 9. Irrigation Subsidies in Selected Developing Countries 1/
(US$ per hectare)

	Revenue from user charges	Operations and maintenance costs	Total capital & other recurrent costs		Revenue as a percent of	
			moderate estimates	high estimate	moderate estimates of total cost	high estimates of total cost
Indonesia	25.9	33	191	387	11.6	6.2
Korea	192.0	210	1,057	1,523	15.2	11.1
Nepal	9.1	16	126	207	6.4	4.1
Philippines	16.9	14	75	166	18.9	9.4
Thailand	8.3	30	151	272	4.6	2.8
Bangladesh	3.8	21	375	...	0.9	...

Source: Repetto (1986).

1/ *Estimates are for 1985.*

Table 10. Irrigation Subsidies in the United States 1/

Irrigation district	Actual current charges ($/acre-foot)	Estimated full supply cost ($/acre-foot)	Revenues as a percent of full costs
Black Canyon	1.41	15.77	8.9
Coachella	7.0	26.27	26.7
Columbia Basin East	4.19	41.16	10.2
Elephant Butte	6.45	24.43	26.4
Farwell	10.50	135.50	7.7
Glen-Colusa	1.46	17.85	8.2
Goleta	59.24	263.12	22.5
Goshen	4.22	22.96	18.3
Grand Valley	1.18	31.10	3.8
Imperial	4.75	11.00	43.2
Lower Yellowstone	5.28	34.62	15.3
Lugert-Altus	18.58	143.19	13.0
Milk River	7.79	119.13	6.5
Moon Lake	1.75	7.05	24.8
Oroville-Tonasket	11.47	21.33	53.8
Truckee-Carson	2.19	33.46	6.5
Wellton Mohawk	4.80	29.58	16.2
Westlands	15.80	67.56	23.4

Source: Repetto (1986).

1/ For 1985.

Table 11. Log Harvesting in Indonesia

Year	Total log harvest (millions of cubic meters)
1960-65 (average)	2.5
1970	10.0
1975	16.3
1976	21.4
1977	22.2
1978	24.2
1979	25.3
1980	25.2
1981	15.9
1982	13.4
1983	14.9
1984	16.1
1985	24.3
1986	25.0
1987	26.0

Source: Repetto (1988).

Table 12. Government Rent Capture in Timber Production 1/

	Potential rent from harvest (1)	Actual rent from log harvest (2)	Government rent captured (3)	(3)/(1)	(3)/(2)
	(in millions of US$)			(in percent)	
Indonesia	4,954	4,409	1,644	37.3	33.2
Philippines	1,505	1,033	171	16.5	11.4

Source: Repetto (1988).

1/ For the period 1979-82.

Table 13. Brazil: Rural Credit Subsidy Rates 1975-81

	1975	1976	1977	1978	1979	1980	1981
Commercial Interest Rate 1/	34.6	34.4	41.1	36.4	44.8	59.4	77.6
Rural credit interest rate 2/	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Effective rural interest rate 3/	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Percentage of interest rate subsidized 4/	86	86	88	86	89	92	94
Percentage subsidy relative to credit amount 5/	49	49	56	51	59	69	76

Source: Reprinted from Repetto (1988).

1/ Rate of return on Brazilian treasury bonds, corrected for changes in CPI and monetary correction.

2/ Interest rate of PROTERRA loans to borrowers in Legal Amazonia.

3/ The internal rate of return equivalent to a credit on PROTERRA terms.

4/ The difference between the commercial and effective rural interest rates, expressed as a percentage of the commercial interest rate.

5/ One minus the present value of debt service payments on PROTERRA loans (calculated at the commercial interest rate as discount factor), divided by the initial loan value.

References

Arrhenius, E., and T.W. Waltz, "The Greenhouse Effect: Implications for Economic Development" (Washington: World Bank, 1990).

Baumol, W.J, Environmental Protection, International Spillovers and Trade (Stockholm: Almqvist and Wiksell, 1971).

_____, and W. Oates, "The Use of Standards and Prices for Protection of the Environment," Scandinavian Journal of Economics, Vol. 73 (Stockholm, 1971).

_____, Economics, Environmental Policy, and the Quality of Life (Englewood Cliffs, N.J.: Prentice Hall, Inc., 1979).

_____, The Theory of Environmental Policy (New York: Cambridge University Press, Second Edition, 1988).

Bird, R., and L. Waverman, "Fiscal Aspects of Controlling Industrial Water Pollution," in Economic Thinking and Pollution Problems, ed. by D.A.L. Auld (Toronto: University of Toronto Press, 1972).

Buchanan, J., and G. Tullock, "Polluter's Profits and Political Response: Direct Control Versus Taxes," The American Economic Review, Vol. 65, No. 1 (Nashville, 1975).

Button, K., "Environmental Externalities and Transport Policy," Oxford Review of Economic Policy, Vol. 6 (1990).

Daly, H.E., "The Economic Growth Debate: What Some Economists Have Learned but Many Have Not," Journal of Environmental Economics and Management (New York), Vol. 14, No. 4 (1987).

Dasgupta, A.K., "On Sustainable Development," in Economics, Growth, and Sustainable Environments, ed. by C.D. Pearce and D. Ulph (New York: St. Martin's Press, 1987).

Flavin, C., Slowing Global Warming: A Worldwide Strategy, Worldwatch Institute (Washington, D.C. 1989).

Hahn, R.W., "Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders," Economic Perspectives, Vol. 3, No. 2 (Nashville, Spring 1989).

Helm, D., and D. Pearce, "Assessment: Economic Policy Towards the Environment," Oxford Review of Economic Policy, Vol. 6, No. 1 (Oxford, Spring 1990).

Hughes, G.A., "A New Method for Estimating the Effects of Fuel Taxes: An Application to Thailand," World Bank Economic Review, Vol. 1 (1986).

_____, "The Incidence of Fuel Taxes: A Comparative Study of Three Countries." In D.M.G. Newbery and N.H. Stern, eds., The Theory of Taxation for Developing Countries, Chapter 12 (1987).

Kelley, M. and Anne K. McGuirk, Issues and Developments in International Trade Policy, IMF World Economic and Financial Surveys (Washington, D.C., August 1992).

Kosmo, M.N., Money to Burn? The High Cost of Energy Subsidies, Working Paper Series, World Resources Institute (Washington, D.C., 1987).

_____, "Commercial Energy Subsidies in Developing Countries: Opportunity for Reform", Energy Policy, Vol. 17 (1989).

Organization for Economic Cooperation and Development, Agricultural and Environmental Policies (Paris: OECD, 1989).

Pearce, D.W., Environmental Economics (London: Longman Group Limited, 1976).

Pezzey, J., "Economic Analysis of Sustainable Growth and Sustainable Development," Environment Department Working Paper 15, World Bank (Washington, March 1989).

Pitt, M., "Equity, Externalities and Energy Subsidies: The Case of Kerosene in Indonesia," Journal of Development Economics, Vol. 17 (1985).

Quibria, M.G., The role of Fertilizer Subsidies in Agricultural Production: A Review of Select Issues, Asian Development Bank (Manila, 1987).

Repetto, R., Paying the Price: Pesticide Subsidies in Developing Countries, World Resources Institute, Research Report No. 2 (Washington, D.C. 1985).

_____, Skimming the Water: Rent-seeking and the Performance of Public Irrigation Systems, World Resources Institute (Washington, D.C., 1986).

_____, "Creating Incentives for Sustainable Forest Development," Ambio, Vol. 27, Nos. 2-3 (Stockholm, 1987).

_____, The Forest for the Trees? Government Policy and the Misuse of Forest Resources, World Resources Institute (Washington, D.C., 1988).

_____, Wasting Assets: Natural Resources in the National Income Accounts, World Resources Institute (Washington, D.C. June 1989).

Robinson, D.H., "Industrial Pollution Abatement: The Impact on Balance of Trade,: Canadian Journal of Economics, Vol. 21, No. 1 (Toronto, 1988).

Rosenblatt, Julius et al., The Common Agricultural Policy of the European Community: Principles and Consequences, IMF Occasional Paper No. 62 (Washington, D.C., 1988).

Schelling, Thomas C., "Some Economics of Global Warming," American Economic Review, Vol. 82 (1992).

Shah, A., and Bjorn Larsen, "Global Warming, Carbon Taxes and Developing Countries" (unpublished, 1992).

Tisdell, C., "Sustainable Development: Differing Perspectives of Ecologists and Economists, and Relevance to LDCs," World Development, Vol. 16, No. 3 (Oxford, 1988).

World Commission on Environment and Development, Our Common Future, Oxford University Press (New York, 1987).