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The Environmental Regime in Developing Countries

Raghbendra Jha and John Whalley

7.1 Introduction

This paper explores the environmental regime in developing countries. By regime, we mean those environmental externalities that are commonly found in the developing world, along with the policy responses, if any, to them. Included are the direct effects of industrial emissions, air- and water-quality impacts of untreated waste (industrial and human), congestion effects of traffic, soil erosion, and open-access resource problems (including forests).

We note the many difficulties involved with adequately characterizing this regime, not the least of which is the heterogeneity across both environmental problems and policy responses in the developing world. Enforcement and compliance (which are typically lax in developing countries) also play a central role in defining this regime. In addition, we note the differences between the experiences of developed and developing countries more generally beyond the environmental area.

In the paper we make three main points. The first is that there is a tendency in much of the literature of the last few years to equate environmental problems in developing countries with pollutants (or emissions).

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Such an approach has been partly influenced by data availability, including that collected by the Global Environmental Monitoring System (GEMS) supported by the United Nations Environmental Program (UNEP). This has yielded data on a range of environmental indicators including biological oxygen demand (BOD), airborne SO_2 concentrations, heavy metal levels,[1] untreated human waste, and other air- and water-quality indicators. This focus on pollutants has meant that in much of the literature there is less emphasis on what others have called degradation. This refers to the effects of uninternalized externalities seen in soil erosion, congestion, open-access resources, and other problems, where physical emissions are less of a problem. The paper argues that discussing environmental problems in developing countries (or comparing them with those in developed countries) without reference to these problems is incomplete; their effects are large and pervasive, and their severity and interaction with economic progress often differ sharply from the effects of pollutants.

The second point is in many ways an elaboration of the first. We have reviewed studies of the social costs associated with incomplete internalization of the externalities we list. The studies that are available are limited in their coverage of both countries and items and, in addition, do not always use consistent methodologies; but the picture they paint is that such costs seem large (perhaps in excess of 10 percent of GDP on an annual basis in some countries), and that these costs are dominated by degradation rather than by pollutant effects (accounting for perhaps three-quarters of the total effect). One implication we draw is that with large cost estimates of inaction, environmental policy in developing countries should perhaps have a higher ranking than it has currently, especially if these cost estimates substantially exceed those of inaction with regard to more conventional policy reform such as tax or trade policy. The other is that if the balance of costs is skewed more to degradation than to the effects of pollutants, degradation should perhaps receive more attention in the literature.

Our third point concerns the relationship among growth, policy reform, and environmental quality; and comparisons of the environmental situation either across economies or over time in light of our characterization of the environmental regime in developing countries. To the extent that recent literature focuses on differences in outcomes across countries or over time in terms of levels of various environmental indicators, the issue is whether degradation effects can give a different picture. We argue that degradation effects could well behave differently from pollutants effects; soil erosion problems, for instance, seem to progressively recede as income per capita rises, since the population in agriculture falls and plot sizes rise; while outward-oriented trade policies draw labor into urban areas from

1. Lead, arsenic, mercury, and cadmium.

rural areas, adding to congestion. We discuss the literature on the environmental Kuznets curve (Shafik and Bandopadhyay 1992; Grossman and Krueger 1995; Andreoni and Levinson 1998) and recent literature on trade and environment (Copeland and Taylor 1994, 1995; Antweiler, Copeland, and Taylor 1998). While the authors contributing to these literatures are clear in labeling their analyses as primarily of pollutant levels, users of this research naturally tend to think of the results as giving guidance on the wider environmental situation in the countries discussed; and without explicit reference to degradation effects, the picture once again can be incomplete.

In the final section, the paper argues that the welfare gains from moving to full internalization would seem to be the more appropriate comparative measure of the severity of environmental problems across countries (or changes over time). The studies referred to seem to suggest that internalization gains relative to GDP are significant for developing countries (and probably larger than for developed countries), raising the issue of why a higher degree of internalization has not occurred. We discuss briefly whether this outcome reflects income elasticities of demand for environmental quality above 1; or whether it reflects technology and capital intensity of environmental management and policy enforcement, so that abatement costs in developing countries are the barrier. We also touch on the role of the political structure in these countries, and on whether a key problem is also in defining and enforcing property rights. In the process we discuss the links between poverty and degradation taken up by Maler (1998).

In concluding, the paper discusses the implications of our characterization of the environmental regime in developing countries for environmental policy in these countries. Can the policy regimes in developed countries be simply transferred, or are there special features that need to be taken into account? Degradation, property rights, and compliance issues seem to be more prominent for developing than for developed countries.

7.2 The Environmental Regime in Developing Countries

We interpret the term "environmental regime" as applied to the developing countries to mean the set of externality-related problems often characterized as environmental, as well as the policy response they induce. Individually, these cover soil erosion, open-access resources (forests and fisheries), congestion (traffic), household emissions (fuel burning), industrial emissions, ground- and surface-water resources (shared aquifers and water-table problems), untreated human and nonhuman waste, and other problems. Property rights and their lack of clear definition, and compliance with environmental controls are two factors closely connected with these problems. Policy responses include regulation (command and control), local actions (village level concerning soil erosion), resource-management policies (forests), and infrastructure development (urban congestion).

For the purpose of our later discussion, we classify these externalities into two broad headings: pollutants, covering industrial and household emissions of various forms and untreated waste; and degradation, covering soil erosion, congestion, and open-access resources. For both of these problem areas, we identify the classical externality literature that applies: A Pigouvian tax will internalize the externality, and the Coasian issues of the assignment of property rights and whether partial internalization can take place through bi- (or multi-)lateral deals once property rights are established also arise.

We could group these externalities in other ways, such as agriculture and rural externality problems, urban externality problems, and environmental problems associated with varying forms of industrial waste. The reasons for grouping these environmental problems in the way we do here relate primarily to measurement issues. They do not reflect any major analytical distinction in terms of the economics, even though, for instance, open-access externality problems for renewable resources have a complex analytical literature characterizing both how replacement of the stock occurs and what constitutes optimal policy across sustainable harvests. Pollutants capture emissions and contaminants of various forms, which can be monitored by such efforts as GEMS. Degradation captures environmental effects for which emissions and contaminants are not the central issue, and for which direct monitoring is more problematic.

We note in passing that the developing countries in which these regimes occur are far from a homogenous group of countries. They vary by per capita income, GDP growth rates, size, the volume and pattern of their international trade, their degrees of urbanization, and many other characteristics. They also vary in the form their environmental problems take; some countries are heavily endowed with environmental assets such as tropical forests,[2] while others are arid and desert; some are mountainous, while others are low lying and flood prone. Generalizing across all developing countries and categorizing the environmental regimes they each face is thus difficult. A few generalizations seem to hold, however; for instance, lower-income countries have proportionately more significant agricultural and rural sectors.

7.2.1 Elements of the Regime

Notwithstanding these problems, in table 7.1 we have set out what we see as the main elements in our characterization of the environmental re-

2. Schatan (1998), for instance, notes that Latin America and the Caribbean account for 50 percent of the world's tropical forests, and five of the ten countries richest in biodiversity worldwide are in the region (Brazil, Colombia, Ecuador, Mexico, and Peru).

Table 7.1 A Pollutant and Degradation Classification Scheme for Environmental Externalities in Developing Countries

Pollutants	
Toxic contaminants	Organochlorines, dioxins, pesticides, grease and oil, acid, and caustic metals (mainly discharges from mines, chemical producers, pulp and paper plants, and leather and tanning factories), which cause health and other problems
Untreated fluid waste	Untreated sewage discharges into rivers, streams, open ditches, which causes waterborne disease
Domestic solid waste	Poorly managed solid waste, which spreads infectious disease and blocks urban drainage channels, with risk of flooding and waterborne disease
Smoke and burning	Burning dung, wood, coal, and crop residues; vehicle exhaust; and smoke, which cause respiratory damage, heart and lung disease, and cancer
Degradation	
Soil erosion	Sedimentary transfer of topsoil to neighboring plots, river estuaries, hydro dams, which causes silting, accompanied by leaching of soil
Soil quality	Pesticide residues, which affect production of neighboring plots
Open-access resources	Ill-defined property rights, which lead to overexploitation of resources (firewood/forests, fisheries; and shared aquifers and water tables)
Congestion and traffic	Poorly regulated traffic, which causes time loss, elevated accident risk, and lowered air quality in urban areas

gime in developing countries, using the broad categories of pollutants and degradation already discussed.

Pollutants in the form of toxic contaminants cover effluents of various types, which come largely from mines, chemical production, pulp and paper plants, and leather and tanning factories. They include organic chlorines, dioxins, pesticides, grease and oil, acid, and caustic metals. These generate health and other problems. The U.N. *Human Development Report* (HDR) (U.N. 1998) estimates that Asia's rivers, on average, contain lead levels 20 times in excess of those in European and North American countries, and claims, by way of example, that in China most toxic solid waste is disposed of in municipal waste streams without treatment.

A second category of pollutant-based externality problems consists of those associated with water quality and untreated fluid waste. It is common in many countries for there to be untreated sewage discharges into rivers, streams, and open ditches. The 1998 HDR suggests that as much as 50 percent of all discharges into waterways in developing countries are untreated. These, in turn, generate significant health problems, including waterborne diseases, which in some countries are rife. The HDR estimates that diarrhea and dysentery account for an estimated 20 percent of the total burden of disease in developing countries; that polluted water generates nearly 2 billion cases of diarrhea annually in the developing world; and that diarrhea-related diseases cause the deaths of some 5 million people annually, including 3 million children. They also estimate that contaminated water leads to 900 million cases of intestinal worms and 200 million cases of schistosomiasis, and that Asian rivers carry 50 times as many bacteria from human excrement as rivers in European and North American countries.[3] The high level of arsenic linked to phosphoric fertilizers in groundwater, which kill some of the people who drink such water, is a further problem in a number of countries.

Another component of the pollutant category is domestic solid waste. In most developing countries, there are only limited solid-waste disposal systems and the result is the spread of infectious diseases. The 1998 HDR estimates that between 20 and 50 percent of domestic solid waste in these countries remains uncollected, even with up to one-half of local government spending in some countries going to waste collection. In some areas, given the lack of sanitation, waste becomes mixed with excrement, further contributing to the spread of infectious disease. Uncollected domestic waste is the most common cause of blocked urban drainage channels in Asian cities, which in turn increases the risk of flooding and waterborne disease. Poorer households in these countries tend to live near waste-disposal sites.

Health-related problems (which include respiratory damage, heart and lung disease, and cancer) due to smoke from burning and to vehicle exhaust in both urban and rural areas reflect another pollutant-based element of the environmental regime. In lower-income countries, these problems come from burning dung, wood, and crop residues. The 1998 HDR estimates that 90 percent of deaths globally due to air pollution are in the developing world and of those 80 percent are due to indoor pollution.

Of the elements of degradation that we identify as part of the environmental regime in developing countries, soil erosion is a major component; although to identify the externality-related component one has to differentiate between on-site and off-site effects. Erosion arises from a variety of causes. One is population growth that results in progressive division of plot sizes, with spillover of topsoil into neighboring plots, river estuaries, hydro dams, and, in the case of countries with more desert areas, windborne soil loss. The 1998 HDR estimates that in Burkina Faso and Mali, one person in six has been forced to leave his or her land because it has turned into desert and that desertification has a worldwide annual cost of $42 billion in lost income, $9 billion of which arises in Africa. Soil erosion reduces agricultural productivity and in some cases the availability of agricultural lands per capita. Soil erosion has also had the effect of reducing fodder available for cattle.

A recent survey paper on studies of the cost of soil erosion in developing countries (Barbier 1998) places the annual losses by country in a range from 1 to 15 percent of GDP. Alfsen et al. (1996), in a study of Nicaragua,

3. This is consistent with Hettige, Mani, and Wheeler's (1997) finding that the environmental Kuznets curve does not hold for waterborne pollutants.

estimate annual productivity losses due to soil erosion by crop—of coffee 1.26 percent, beans 2.52 percent, maize 2.41 percent, and sorghum 1.35 percent. Magrath and Arens (1989), in a study of soil-erosion losses in Java in 1985, estimate annual losses of approximately 4 percent of the value of crops harvested. Cruz, Francisco, and Conway (1988),[4] examining two watersheds in the Philippines and focusing only on additional sedimentary costs for hydro-power installations (reduced water-storage capacity for hydro power, reductions in the service life of the dam, and reduced hydro power), estimate annual costs of $27 per hectare of agricultural land in the watershed, a significant portion of the value of crop yield. Soil-quality problems arise from the leaching of pesticides to neighboring plots, contaminating neighbors' soil.

In addition to soil erosion and soil quality, other degradation-type externalities arise with open-access resources (resources for which the property rights are ill-defined or poorly enforced) and the overexploitation of these resources. These include deforestation associated with land clearing, slash-and-burn cultivation, squatting, and, in some countries, the collection of firewood. These problems are especially severe in Africa and in Central and Latin America; Schatan (1998), for instance, identifies land degradation as the most serious environmental problem facing Latin and Central America. For Ghana, one of the less severe cases, López (1997) estimated that overcultivation of land at the expense of forests runs to 25 percent of land use. Overexploitation of fisheries is a further major problem. Shared access to water through common aquifers and groundwater is yet a further manifestation of the problem; this results in reduced water tables, causing especially severe problems in the north China plain.

Finally, in this regime under the heading of degradation are urban congestion problems. Rapid growth in urban population and vehicle densities, especially in high-growth economies, leads to congestion. This lowers air quality; increases the spread of infectious disease; and generates significant time loss from traffic, high accident rates, and noise. A 1990 study by Japan's International Cooperation Agency[5] produced the estimate that road congestion in Thailand (one of the worst cases) reduces potential output in the Bangkok region by one-third.

In closing this discussion, we also note that the environmental regime in developing countries is characterized by policy measures that frequently exhibit lax enforcement. As in the developed world, the primary form that environmental policy toward industrial emissions takes in developing countries is the use of command and control instruments of various forms. These involve the setting of standards and monitoring (with penalties for

4. Cited in Barbier (1998).

5. Cited in *The Economist,* 5 September 1998, although we should note that the estimate is substantially in excess of those in other studies we mention later.

violators), but a common feature is the presence of only limited compliance due to weak enforcement. For household wastewater, soil erosion, and other nonindustrial environmental problems, there is little or no abatement of damage in many countries.

7.2.2 The Costs of Environmental Damage in Developing Countries

If this is the regime, what are its consequences? In table 7.2 we report some estimates of the costs of environmental damage for six countries, each associated with the elements of the regime we identify. Cost estimates of this form are relatively few and are scattered throughout the literature. The methods and data used to construct them are not always fully available, and there are variances in their findings. Most of these estimates do not directly refer to the welfare costs of the environmental damage, but instead use some other measure (such as the value of work time lost due to health impacts). We rely heavily on a synthesis of studies of environmental damage for a sample of Asian economies that has recently been drawn together by the Asian Development Bank (ADB) and reported in the 1998 HDR. These, together with results of a related study by the World Resources Institute (WRI), are presented in table 7.2.

In the case of China, the ADB studies suggest that annual productivity losses due to soil erosion, deforestation, and land degradation could be as high as 7 percent of GDP for the early 1990s. If the health and productivity losses from pollution in cities are added (in the region of 1.7–2.5 percent of GDP), combined annual cost estimates from environmental damage are in the region of 10 percent of GDP. Even this estimate excludes a number of key components of environmental damage, such as those due to conges-

Table 7.2 Some Estimates of Environmental Costs in Selected Asian Countries

China	Productivity losses due to soil erosion, deforestation and land degradation, water shortages, and destruction of wetlands in 1990 of $13.9–26.6 billion annually or 3.8–7.3 percent of GDP; health and productivity losses from pollution in cities in 1990 of $6.3–9.3 billion or 1.7–2.5 percent of GDP
India	Total environmental costs of $13.8 billion in 1992 or 6 percent of GDP; urban air pollution costs of $1.3 billion; health costs from water quality of $5.7 billion; soil erosion costs of $2.4 billion; deforestation costs of $214 million (traffic-related costs, pollution costs from toxic wastes, and biodiversity losses excluded)
Indonesia	Health costs of particulate and lead levels above WHO standards in Jakarta of $2.2 billion in 1989 or 2.0 percent of GDP
Pakistan	Health impacts of air and water pollution and productivity losses from deforestation and soil erosion of $1.7 billion in the early 1990s or 3.3 percent of GDP
Philippines	Health and productivity losses from air and water pollution in the Manila area of $0.3–0.4 billion in the early 1990s or 0.8–1.0 percent of GDP
Thailand	Health effects of particulate and lead levels in excess of WHO standards of $1.6 billion or 2 percent of GDP

Source: Agarwal (1996); ADB (1997); U.N. (1998).

tion from traffic-related problems. A further study of China by Smil (1992) based on 1988 data puts losses due to environmental degradation (farmland loss, nutrient loss, flooding, and timber loss) at around 10 percent of GDP, compared to losses from pollutants (waterborne pollutants that reduce crop yields, fish catches, industrial output; airborne pollution that results in higher morbidity, reduced plant growth, damage to materials; and soil pollution that reduces crop yields) of perhaps 2 percent of GDP.

Estimates of the cost of damage from a series of environmental sources in India in 1992 are approximately 6 percent of GDP in the ADB studies. The elements included urban air pollution, health costs from water quality, soil erosion, and deforestation, while the study excludes traffic-related costs, pollution costs from toxic wastes, and biodiversity losses.

The other studies included in table 7.2 are less complete in their coverage of environmental damage. Studies for Indonesia of the health costs of particulate and lead levels (gasoline related) set these levels above those laid down as standards by the World Health Organization (WHO), at approximately 2 percent of GDP in 1989. In Pakistan the health impacts of air and water pollution along with productivity losses from deforestation and soil erosion are estimated at approximately 3.5 percent of GDP in the early 1990s. The ADB studies of the Philippines concentrate on the Manila area alone and look at the effects of lowered air and water quality; the cost estimate for this component of damage is approximately 1 percent of GDP. In Thailand, the health effects of particulates and lead levels (gasoline related) in excess of WHO standards are put at 2 percent of GDP.

Table 7.3 reports estimated time-loss costs from traffic congestion for a sample of Asian cities. These are also cited in the 1998 HDR and are in addition to those costs listed in table 7.2. For Bangkok time-related costs from traffic are estimated at 2 percent of local product in 1994; these estimates are 0.4 percent for Seoul in the same year. Health-related costs of traffic are already included in the studies referred to in table 7.2.

Table 7.3 **Estimates of Time Losses due to Traffic Congestion in Asian Cities, 1994**

City	Annual Cost of Time Delays (millions of dollars)	Cost (percentage of local citywide product)
Bangkok	272	2.1
Kuala Lumpur	68	1.8
Singapore	305	1.6
Jakarta	68	0.9
Manila	51	0.7
Hong Kong	293	0.6
Seoul	154	0.4

Source: WRI (1996); U.N. (1998).

What is striking about these two sets of studies is that, in the case of the two more comprehensive country studies (China and India), the estimates for the combined environmental damage are large, in the region of 10 percent of GDP in the case of China, neglecting damage from additional sources such as time loss in traffic. Given that model-based analyses of the gains from more conventional policy reform (such as tax or trade reform) in those countries often produce estimates that are lower (perhaps 1–3 percent of GDP), this suggests that environmental policy should perhaps receive a higher weighting in the overall policy stance in these countries than it does currently.

In addition, the composition of environmental damage costs in these countries is striking. The studies of China in the ADB compendium suggest that perhaps 70–80 percent of environmental damage occurs through degradation, largely in rural areas; a range echoed in Smil (1992). While the numbers for India are perhaps less dramatic, the high estimates of the costs of soil erosion outside Asia[6] seem to us to support our contention that the degradation of the environment rather than damage caused by pollutants may well be the more important environmental issue in developing countries.

7.2.3 Transborder Environmental Externalities and the Environmental Regime in Developing Countries

Developing countries both contribute to and are affected by a range of transborder and global externality problems. In table 7.4 we list some of the more major transborder and global environmental externalities involved, both those affecting and those contributed to by developing countries. These also form part of the typical environmental regime in developing countries, and, although we do not emphasize them here, we mention them nonetheless.

Global warming is perhaps the more major transborder environmental issue for the developing countries, with temperature rise and microclimate changes as the projected outcome, combined with increased frequency of extreme weather events. The possible impacts on developing countries are thought to be potentially more significant for low-terrain countries such as Bangladesh, as are the adjustment problems faced by smaller countries as microclimates change (such as in western Africa) and labor flows across borders.

Further transborder elements forming part of the environmental regime in these countries include the thinning of the ozone layer, which increases ultraviolet-light penetration of the atmosphere. These effects are more severe in the temperate climates of developed countries than in the developing countries, but the ability of the developing countries to abate damage of this type is more limited than that in the developed world, especially

6. See Barbier (1998) and Schatan (1998).

Table 7.4 **Transborder and Global Environmental Externalities Affecting Developing Countries**

Global warming	Temperature rise and microclimate change, combined with increased frequency of extreme weather events
Ozone depletion	Thinning of ozone layer increases ultraviolet-light penetration of the atmosphere; effect more severe in temperate climates
Biodiversity loss and deforestation	Loss of gene pool through forest and wildlife erosion (e.g., mangrove losses linked to shrimp farming); loss of forests affects local populations who use nontimber forest products, reduces carbon absorption by forests, and increases water runoff in flooding
Acid rain	Airborne acid depositions; high in areas such as south and east China, north and east India, Korea, and Thailand (e.g., wheat yields halved in areas of India close to SO_2 emissions)

because much of the population spends a larger fraction of their time outdoors.

We also include problems associated with loss of biodiversity and deforestation as a part of the transborder and global regime. For loss of biodiversity, the issue is loss from the gene pool through flora and fauna damage. The environmental effects of economic activities that affect resources with global existence value (including species and biodiversity) is one aspect. Shrimp farming, for instance, has grown in the last 2 decades from initially low levels in Thailand and other countries, and with it has come a significant loss of mangroves and a resulting loss of biodiversity. Many pharmaceutical products sold worldwide each year are generated from forest-related sources in developing countries. The global impacts of forest loss occur through many channels, including carbon-sink reduction and impacts on existence value abroad. But forest loss also affects local populations who use nontimber forest products can cause increased water runoff in the event of flooding.

Acid-rain problems include airborne acid deposits affecting buildings and agricultural yields; these problems are especially significant in such areas as south and east China, north and east India, Korea, and Thailand. The 1998 HDR reports that in areas in India that are close to SO_2 emissions sources (admittedly mostly originating in India) the wheat yields are estimated to have been halved due to these emissions. While these global and transborder externalities are also part of the environmental regime in developing countries, both their impact on individual countries and the contribution of countries to global damage because of them remain poorly quantified.

7.3 Growth, Policy Reform, and the Environmental Regime in Developing Countries

The discussion in section 7.2 emphasized the wide range of externalities that make up the environmental regime in developing countries, along with the seeming quantitative dominance of environmental problems associated with degradation over those associated with pollutants. But how does this regime change as countries grow? Does environmental quality improve or worsen, and in what dimension and for what reasons? And what policy measures contribute to the environmental situation, either positively or negatively?

7.3.1 The Environmental Kuznets Curve

One of the more prominent of the recent discussions on these issues focuses on the environmental Kuznets curve (EKC). The EKC refers to the relationship between environmental indicators of certain types and per capita incomes of countries; its origins lie in Kuznets's work in the 1950s on income inequality measures across developing countries, which documented a clear trend initially toward increased inequality as per capita income grows, with a subsequent fall. This work suggested an inverted U shape for a cross-country plot of an inequality measure such as a Gini coefficient against income per capita. The EKC hypothesis is that environmental indicator levels first rise (e.g., pollutant levels per capita rise) as per capita income rises; then the relationship reverses after some threshold level of income.

The implication drawn by some from EKC plots is that growth need not be inconsistent with the objective of improving environmental quality in the medium to longer run: Environmental concerns can be delinked from growth objectives. Indeed, some authors have gone further and argued that the best way to improve environmental quality is to follow policies that make countries rich in the shortest possible time, since in the long run there is no conflict between growth and environmental protection. Andreoni and Levinson (1998) and Jaegar (1999) have recently provided microfoundations for the EKC, arguing that the characteristics of cleanup technology are key to the EKC.

The first paper in this area, by Shafik and Bandopadhyay (1992) (a background study for the 1992 *World Development Report,* World Bank 1992 with results given prominent profile in the report itself), examines a range of environmental indicators. These include lack of clean water, lack of urban sanitation, ambient levels of suspended particulate matter (SPM), ambient sulfur oxides, change in forest area during the period 1961–86, the annual rate of deforestation between 1961 and 1986, dissolved oxygen in rivers, fecal coliforms in rivers, municipal waste per capita, and carbon emissions per capita. Their sample consists of observations of up to 149 countries for the period 1960–90, although their coverage is incomplete. Some of the dependent variables are observed for cities within countries, in other cases for countries as a whole. Only in the case of air pollutants is an EKC type relation found. Lack of clean water and lack of urban sanitation are found to decline uniformly, both with increasing income and over time. Deforestation seems to be unrelated to income. River quality tends to monotonically worsen with income.

Selden and Song (1994), following Shafik and Bandopadhyay (1992), focus exclusively on air pollutants in their examination of possible EKC relationships. They study emissions of SO_2, NO_X, SPM, and CO. Emissions are measured in kilograms per capita on a national basis with pooled cross-sectional and time-series data drawn from WRI. The data are averages for 1973–75, 1979–81, and 1982–84. There are 30 countries in their sample: 22 high-income, 6 middle-income, and 2 low-income countries. Their results indicate that emissions of CO are independent of income, whereas emissions of other pollutants follow an EKC pattern. However, the turning points occur at much higher levels of income than in the Shafik and Bandopadhyay (1992) study.

Grossman and Krueger (1995) have subsequently investigated EKC relationships using the GEMS cross-country data on air quality for the period 1977–88 and isolate a series of environmental indicators: SO_2 concentration in selected cities, smoke, dissolved oxygen in water, BOD, chemical oxygen demand (COD), nitrates, fecal coliform, total coliform, lead, cadmium, arsenic, mercury, and nickel. The data measure ambient air quality at two or three locations in each of a group of cities in a number of countries during the period 1977–88. The number of observations varies over time (52 cities in 32 countries in 1982, but only 27 cities in 14 countries in 1988). The authors claim that the data are representative of countries at varying levels of economic development and with different geographical conditions, and they find an EKC type relation for SO_2, smoke, dissolved oxygen, BOD, COD, nitrates, fecal contamination of rivers, and arsenic. The evidence is less compelling for total coliform and heavy metals.

Also in the literature is Panayotou (1993), which estimates EKC-type relationships for SO_2, NO_X, and SPM, and deforestation using cross-sectional data for 1985 and, as in Selden and Song (1994), pollutants measured in emissions per capita on a national basis. Panayotou finds EKC-type relations for SO_2, NO_X, and SPM. Turning points were at levels of income lower than those in Selden and Song (1994). Cooper and Griffiths (1994), in contrast, estimate three regional (Africa, Latin America, and Asia) EKCs for deforestation only, using pooled cross-sectional time-series data for each region for the period 1961–91 and for 64 countries. They find no EKC relationship.

These findings are such that it is now often argued that attempts to estimate EKC-type relationships should be confined to air pollutants alone, and, in particular, to SO_2 emissions. As a result, drawing conclusions from any EKC plot as to how overall environment damage behaves as income changes is thought to be fraught with problems.

But even for SO_2, the EKC does not appear to be a particularly robust description in the current literature of the behavior of environmental pollutants vis-à-vis income per capita. Kaufman et al. (1998) point out a number of econometric problems with EKC estimates, including violations of homoscedasticity, the nonuse of random- and fixed-effects methods in panel data, the improper definition of dependent and independent variables, and other problems. Kaufman et al. try to circumvent these difficulties in their attempt to identify an EKC-type relation in the case of SO_2, defining SO_2 concentrations as annual average concentrations in ground-level atmosphere at a particular location in a city. Using a panel of 23 countries (13 developed, 7 developing, and 3 centrally planned) during the period 1974–89, their analysis shows an EKC-type relation between emissions per capita and spatial intensity of economic activity, as well as between emissions per capita and GDP per capita. However, they also find evidence that still further increases in income per capita lead to a further increase in emissions per capita—an N-type rather than inverted-U-type relation between emissions per capita and GDP per capita.

Unruh and Moomaw (1998) evaluate whether the transition from a high emissions to a low emissions state occurs mechanically at a particular income level, as suggested by earlier papers. They identify some industrialized countries that seem to have gone through EKC-type transitions, discovering that these transitions span a broad range of income levels.[7] Furthermore, the transitions occur abruptly and cotemporally and do not appear to be the consequence of endogenous income growth. Rapid and cotemporal historical events, technological progress, and the need to react to external shocks seem to drive the EKC structure. Ekins (1997) argues that the pattern of emissions of selected air pollutants does not indicate the environmental impact of such emissions and examines an aggregate indicator of environmental impact developed by the Organization for Economic Cooperation and Development (OECD). Examining the relationship between this indicator and income per capita, Ekins finds no evidence in favor of an EKC.

Thus, even considered within its own confines, the relation between economic growth and environmental damage seems more complex than portrayed by the EKC (Barbier 1997). There appears to be nothing automatic about this relation, nor is any inference on causality necessarily justified. Once degradation effects are added in, drawing conclusions as to how overall environmental quality changes with income is even more treacherous. For instance, soil erosion problems, measured relative to aggregate income, would seem to recede as growth occurs and (in relative terms) the agricultural sector shrinks. But growth is accompanied by urbanization

7. In a recent paper, Torras and Boyce (1998) take the existence of the EKC at face value and ask whether it is merely the level of income or also its distribution that affects emissions per capita. They argue that a more even distribution of income, higher literacy rates, and other indicators of power lead to lower emissions per capita.

and congestion problems, which, relative to income, may recede after a transitional period when growth and new infrastructure are taking hold.

7.3.2 The Environmental Effects of Policy Reform (Trade and Environment)

A further strand of the recent literature attempts to assess how environmental quality changes with policy changes, including trade liberalization; in particular how various kinds of pollutant concentrations can be affected. Copeland and Taylor (1994), for instance, evaluate the role of trade where environmental quality is a local public good (i.e., damage from pollutants remain in the country). They consider a two-country single-period equilibrium where goods differ in pollution intensity in production. Countries differ in their endowment of a primary factor (human capital); environmental quality in both countries is a normal good in preferences, and, with assumed endogenous setting of pollution policy, the higher-income country has higher environmental standards. They find that free trade shifts pollution-intensive production toward countries scarce in human capital and raises world pollution levels.

Copeland and Taylor (1995) consider a different case where environmental quality is a pure public good to which all countries are exposed. Trade effects are different in this case, since relocation of pollution-intensive industries to countries with less stringent environmental protection can increase the exposure of residents in the home country and works against more conventional gains from trade. Since there are transborder externalities in this case, nationally based pollution regulation does not lead to Pareto optimality, and free trade need not raise welfare.

More recently, Antweiler, Copeland, and Taylor (1998) first generate and then test a series of propositions as to how economies behave in terms of their trade and environment linkages. They assume a small, open economy formulation: The economy has a number of agents, produces two final goods, and uses two primary factors. One product is labor intensive and involves no pollution, whereas the other is capital intensive and causes pollution. They assume producers have access to an abatement technology, which, for simplicity, only uses the polluting good as an input. They also assume that the government uses emissions taxes to reduce pollution, and, given the pollution tax rate, they generate a firm-level profit function.

The level of the tax actually used is assumed to be an increasing function of what an optimally set tax would be. This treatment allows government behavior to vary across countries and also allows for environmental policy to respond and differ by country: On the demand side, consumers maximize utility, taking pollution as given; they assume preferences over goods are homothetic, while there is constant marginal disutility of pollution.

The model allows them to decompose a total change in pollution levels into scale, composition, and technique effects. This, in turn, allows them to generate a number of theoretical propositions to test. Thus, if economies differ only with respect to their degree of openness to trade, and both countries export the polluting good, then pollution will be higher in the country that is less open. Where the world price is fixed, then for a given level of income and for certain settings of key model parameters, they show that the composition effect associated with trade liberalization in such countries is to increase pollution. These and other propositions as to how the links between trade and environment operate emerge from their analysis as they focus on emissions associated with trade-related polluting activity.

However, as our earlier discussion indicates, emissions are likely to constitute only a portion of the overall welfare cost of environmental externalities in liberalizing developing countries, and other environmental externalities may well have different interactions with trade. Thus, if with increased trade labor moves from rural to urban areas and if this generates increased congestion, these adverse consequences linked to trade can easily dominate the overall environmental impact compared to changes in emissions. Impacts on soil erosion from agricultural trade liberalization abroad can be adverse, while being beneficial at home. Liberalization in the manufactured sector can produce opposite implications for soil erosion. A wider view of the environmental regime in developing countries can thus also produce different conclusions as to what the key linkages between policy changes and the environment actually are.

7.4 Measuring the Degree of Environmental Failure in Developing Countries

Given the preceding discussion, if pollutant levels across economies do not provide a complete picture for the evaluation of comparative environmental performance across countries or over time, either in analytical or empirical work, what is a more appropriate way to proceed? Unfortunately, the problem is not only the incomplete coverage of environmental externalities in developing countries; one also needs estimates of damage functions, which allow the losses involved to be computed in terms of welfare. Thus, even if economies have high levels of emissions per capita, if the ability to abate differs across economies (such as health care capabilities to deal with adverse effects of emissions), then differences in emissions levels across countries do not necessarily map onto comparable differential welfare losses due to environmental failures. In the appendix to this chapter we show for the special case of a stock externality that, even if an EKC relationship is followed in emissions per capita, this need not map onto a comparable relationship in terms of welfare.

For these reasons, therefore, an alternative approach is needed to evaluate the significance of environmental failures across economies or over time, and hence to assess the impact of the environmental regime in devel-

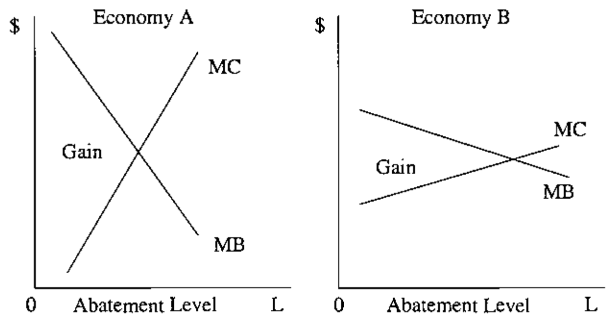

Fig. 7.1 Abatement levels and welfare gains from internalization in two economies

oping countries. The appropriate concept to us seems to be a distance measure reflecting the severity of the departures from Pareto optimality associated with externalities—how far away are economies from Pareto optimality in a welfare sense, and what would be the potential welfare gains from moving from the current allocation of resources with uninternalized or partially internalized externalities to complete internalization? The implied measure seems to be a money-metric measure (say a Hicksian measure) of the gain from internalization relative to a current noninternalized equilibrium. Income effects associated with different assignments of property rights would affect the precise fully internalized equilibrium, although we put these issues to one side for now. Such a measure of gain is implicit in the literature discussed in section 7.2, which produces estimates of the costs of various kinds of environmental failures in terms of GDP per capita; but much of this literature is not explicit about the precise welfare formulation used.

Such measures need not behave in any way that is necessarily collinear with levels of emissions or intensity of environmental failure. Figure 7.1 shows schematically how a comparison across two economies with differing levels of emissions may yield larger gains to the economy with smaller emissions. Here, we represent marginal benefit (MB) and marginal cost (MC) of abatement functions for two economies. Economy A has more steeply sloped functions, and in Pareto optimality has smaller abatement than B. But the gains from abatement (internalization) are larger in A than in B because of the more shallowly sloped functions in B. Comparing pollutant levels across economies need give no guide as to the relative size of the gains from internalization.

The seemingly large estimates we reported earlier of the gains from internalizing environmental externalities in developing countries also suggest the perhaps obvious question of why it is that if internalization gains are so large, more internalization has not occurred. It would be wrong to say that no internalization has occurred in these countries. At the village level, terracing and other schemes are designed to remedy some of the ills of soil erosion. National environmental regulation often approaches levels of stringency seen in regulation in developed countries, but is accompanied by problems of enforcement and compliance. In many developing countries, environmental nongovernmental organizations (NGOs) are also extremely active, generating a rising profile for environmental issues in local policy debate, even though large potential gains from internalization still seem to remain.

Various explanations abound for the presence of these seemingly large potential gains. One is that the technology of internalization is both capital intensive and high cost for low-income countries. Monitoring devices and administration of environmental fees and fines all require inputs on a scale not easily attained in low-income countries. Another is that if environmental quality is costly to provide, then models with traditional preferences and technology would naturally imply that abatement levels are lower in low-income countries. These effects, in turn, would be exacerbated by income elasticities of demand for environmental quality exceeding 1, as is often claimed.

Another direction explored in recent literature (see López 1998; Maler 1998) is that outside shocks to social systems are a significant compounding factor, either disrupting or delaying internalization and producing lowered environmental quality. Particularly important in this discussion is the observation that environmental management systems in developing countries commonly rely on informal social norms, which can partially or wholly break down under rapid population growth, technological innovation, or changes in market outcomes. Previously reasonably well-managed resources can become open-access, poorly managed resources, with worsened environmental quality the result. Dasgupta and Maler (1991) argue that, viewed in these terms, poverty and degradation can even be reinforcing. Thus, if deforestation moves the available firewood in forests progressively further from villages, families may have more children to offset the increased time required to collect firewood.[8] Population growth is higher and with it the demand for firewood, producing further degradation.

7.5 Comparing Policy Regimes in Developed and Developing Countries

We often tend to think of developing countries as following the developmental experience of developed countries with a form of compressed lag.

8. This hypothesis has been tested empirically by Filmer and Pritchett (1996) using household data for Pakistan for 1991–92. They conclude that households living in areas in which the distance from firewood is greater have more children.

OECD countries over some 200 years have grown and developed, transforming themselves first from agrarian societies to industrial economies based on heavy industry (steel and chemicals) to modern high-technology service-based economies. Developing countries are following this experience at varying speeds and in different ways, but the transition time is clearly shorter. Korea, for instance, has transformed itself from a country with lower income per capita than India in the mid-1950s to a lower-income OECD country today—a 40-year transition. Furthermore, unlike developed countries at the height of their industrial growth, developing countries today are under considerable pressure to reduce environmental stress. This pressure (sometimes backed by the threat of punitive action) comes from a number of sources, such as governments of developed countries, international funding agencies, academia, local and international NGOs, and the developing countries' own bodies of jurisprudence. Such pressures were unheard of during the days of rapid industrial growth of the currently developed countries.

It is only relatively recently, however, that developed countries have gained the environmental awareness they now have and have developed systems of environmental management that control emissions, treat waste, and otherwise abate environmental damage. At the height of the OECD countries' industrial revolutions, effectively no environmental controls were in place.

What then should developing countries do? The experience of developed countries would seem to indicate that they should adopt few environmental controls and that with income growth environmental quality will improve. Indeed, a great fear is that attempts to heighten environmental regulation will only serve to slow growth and, hence, slow eventual achievement of higher environmental quality through growth. On the other hand, because of problems of compliance one can argue that perhaps developing countries have no choice but to follow the older developed countries' industrial revolution experience of largely benign neglect.

There are, however, some key differences in the developing countries' experience in this area compared to the industrial revolution of old. First, the time periods involved are compacted, and hence the flow of environmental damage per year during industrialization is larger. Second, the shocks that hit the economies are also much more severe than was true of the old industrial revolutionizers. The industrial-revolution-era economies of the developed countries simply did not experience population growth rates of 3 percent or more per year, massive growth in urban vehicle densities, and other elements that contribute to today's environmental ills in the developing world. Not only is the process more compact, the time-adjusted severity of damage probably exceeds that experienced in the OECD 100 years ago. Third, even though weakly administered, there are abatement technologies that can be and are being employed; and even though there is political opposition, environmental management is taking root.

Thus, the large cost estimates we reported earlier and the scope of environmental problems in developing countries suggest to us that a much more activist environmental policy regime will continue to emerge in developing countries than was true in industrial countries some 100 years ago as they grew and industrialized. And, unlike the past, this regime will have an equal focus on degradation, if not a dominant focus on degradation over pollution.

7.6 Concluding Remarks

This paper discusses the environmental regime in developing countries, stressing both the complexity of the regime and the wide-ranging nature of environmental externalities that go beyond more conventional literature discussion of pollutant levels. It suggests that a full characterization of this regime needs to focus on externality problems such as soil erosion, open-access resources, and congestion problems in urban areas. The paper stresses that from available studies the gains from internalization of these externalities seem to be large, potentially exceeding numerical (model-based) estimates of gains from conventional policy reforms (such as trade or tax reform) by substantial orders of magnitude. Also, the majority of such gains seem to arise from internalizing externalities associated with degradation (soil erosion, open-access resources, and congestion) rather than pollution. We also stress how existing literature that discusses how the environmental situation changes with growth (the EKC) covers only part of the environmental situation; a point that also applies to other parts of the literature such as that on policy reforms (trade liberalization) and environmental quality.

Having developed this picture of the environmental regime in developing countries, the paper concludes by suggesting that a measure is needed of overall environmental performance in terms of departures from Pareto optimality so as to give a money-metric welfare measure of the gains of moving to complete internalization. It also discusses some of the reasons for the lack of internalization, citing recent literature that argues that social conventions defining implicit management regimes come under stress as rapid urbanization, rapid population growth, and other shocks to social systems occur. The overall theme of the paper, repeated throughout, is that in discussing the environmental situation in developing countries, a more comprehensive sense of what this regime comprises is needed.

Appendix

Internalization Gains and the Environmental Kuznets Curve

The EKC literature discussed in this chapter seemingly points to the conclusion that there is no clear evidence in favor of the EKC. Even though the EKC itself may be empirically dubious, its welfare interpretation also has to be highly qualified. Here, we develop a model where optimality is defined as internalization, and since such internalization is, in principle, independent of the level of emissions, the EKC even if it were to exist lacks any welfare content. We use an amended version of the growth with stock externalities model, showing that alternative technological assumptions can give us different (optimal) relations between emissions and income, and each such relation is consistent with perfect internalization. The emphasis in the model is on shadow pricing the external effect appropriately (Ko, Lapan, and Sandler 1992).

In the model, (1) labor is normalized to equal 1. (2) Output, y, depends upon capital, k, and emissions, e, $y = f(k, e)$. An important point here is the nature of the relationship between k and e. We assume that $f_{ke} > 0$, (i.e., capital and emissions are substitutes). We further assume that there exists a level of emissions $\bar{e}$ such that the marginal product of emissions for a given level of capital is 0. (3) Capital accumulates according to the equation

(A1) $$\dot{k} = f(k,e) - c - \delta k,$$

where c is consumption and δ is the rate of depreciation of capital. (4) Pollution accumulates according to the relation

(A2) $$\dot{S} = -bS + e,$$

where b is fixed.

The social planner's problem is to choose nonnegative consumption and emissions paths that solve the infinite horizon maximization problem,

(A3) $$\int_0^\infty e^{-\rho t} U(C,S)dt,$$

subject to equations (1) and (2). Here $U(\cdot)$ is the instantaneous utility of the representative consumer and ρ is the discount rate. The Hamiltonian for this problem is

(A4) $$H(k,S,c,e) = U(c,S) + \theta_1(t)[f(k,e) - c - \delta k] + \theta_2(t)(e - bS),$$

where θ_1 and θ_2 are costate variables. First-order conditions imply

(A5) $$U_c = \theta_1,$$

assuming we always have an interior solution; and

(A6) $$\theta_1(\partial f/\partial e) + \theta_2 \leq 0,$$

with equality if $e^*(t) > 0$. The canonical equations are

(A7) $$\dot{\theta}_1 = [\rho + \delta - (\partial f/\partial k)]\theta_1,$$

(A8) $$\dot{\theta}_2 = [(\rho + b)\theta_2] - \partial U/\partial S,$$

and transversality conditions apply:

(A9) $$\lim_{t\to\infty} e^{-\rho t}\theta_1(t) = \lim_{t\to\infty} e^{-\rho t}\theta_2(t) = \lim_{t\to\infty} e^{-\rho t}k(t) = \lim_{t\to\infty} e^{-\rho t}S(t) = 0,$$

which require that the present value of capital and pollution becomes negligible at infinity.

This welfare exercise refers to the optimal solution obtained in a command economy. From the first-order conditions we can solve for optimal consumption and optimal emissions as $c^* = c(k, S, \theta_1, \theta_2)$ and $e^* = e(k, S, \theta_1, \theta_2)$. If we assume that the production and the utility functions are strictly concave in this case, then for given values of parameters, c^* and e^*, the issue is how this may be expected to vary with c. If we use this result of θ_2, then it follows that, from a welfare point of view, the relationship between consumption and emissions is monotonically falling. Richer countries will have higher θ_2 and therefore, lower emissions ceteris paribus than poorer countries.

In a competitive market economy the representative consumer takes as given time paths $\{w(t), r(t), \pi(t)\}$ for $t \varepsilon [0,\infty)$, of wages, interest rates, and profits. The instantaneous utility of the consumer is defined by $U(c, S)$ as before. The consumer sells the fixed labor input (normalized to unity) to a representative firm at the market-determined wage rate, and rents out capital, $k(t)$, at the market rate of interest to the firm. The representative firm maximizes profits under competitive conditions. It generates emissions $e(t)$ per unit time and pays a tax $\lambda(t)$ on these emissions. Total tax proceeds collected by the government are redistributed to the consumer. The consumer maximizes utility and has perfect foresight about market wage rates and other variables.

The consumer maximizes

(CP) $$\int_0^\infty e^{-\rho t}U(c(t), S(t))dt,$$

subject to

$$\dot{k} = \pi(t) + rk(t) + \lambda(t)e(t) - c(t) - \delta k(t),$$

and treats S as a parameter. The variable ρ is the consumer's discount rate and δ is the rate of depreciation of capital.

The firm takes as given (and has perfect foresight about) time paths of emissions taxes $\{\lambda(t), t\varepsilon, [0,\infty)\}$ along with the time paths of wage and interest. The firm can reduce its tax liabilities by reducing output. Output is produced according to a standard neoclassical production function so that the firm chooses $k(t)$ and $e(t)$ to solve the problem

(FP) $$\max \pi(t) = f(k(t),e(t)) - r(t)k(t) - \lambda(t)e(t).$$

Given that the consumer perfectly predicts the time paths of $\{w(t), r(t), \pi(t)\}$ and the firm perfectly predicts the time paths of $\{w(t), r(t), \pi(t)\}$, then the consumer will determine consumption demand (c^d) and capital supply (k^s), whereas the firm will determine consumption supply (c^s) and capital demand (k^d) and the emissions $e(t)$. The paths $\{w(t), r(t), \pi(t), \lambda(t)\}$ are a perfect foresight competitive equilibrium with emissions taxes if the solution $\{c^s(t), k^d(t), e(t)\}$ of equation (FP) is such that if profits are defined by $\pi(t) = f(k(t), e(t)) - r(t)\, k(t) - \lambda(t)\, e(t)$ for each t and if $\{c^d(t), k^s(t)\}$ solves equation (CP), then for all $t\varepsilon$ $[0,\infty)$ we have (1) $c^d(t) = c^s(t)$ goods market or flow equilibrium; (2) $k^s(t) = k^d(t)$ capital market or stock equilibrium; (3) $e^c(t)$ is the competitive emissions; and (4) $S = e^c(t) - bS(t)$, $S(0) = S_0$ (evolution of pollution stock).

An examination of the planner's problem in equation (A1) immediately reveals that if the emissions tax is defined as $\lambda(t) = -\theta_2(t)/\theta_1(t)$, the competitive equilibrium solutions for equations (CP) and (FP) for the firm are identical to the solution of the social optimization problem. To see this, assume that equation (FP) has an interior solution; then we must have

(A10) $$\partial f/\partial k = r,$$

(A11) $$\partial f/\partial e = \lambda.$$

These determine the demand for capital and the competitive supply of emissions. Given this, then the consumer maximizes the following Hamiltonian:

(A12) $$H = U(c,S) + \gamma(t)(\pi + rk + \lambda e - c - \delta k).$$

The first-order conditions are

(A13) $$\partial U/\partial c = \gamma,$$

(A14) $$\dot{\gamma} = (\rho + \delta - r)\gamma,$$

(A15) $$\dot{k} = \pi + rk + \lambda e - c - \delta k \quad \text{with } k(0) = k_0.$$

The transversality conditions are

(A16) $$\lim_{t\to\infty} e^{-\rho t}\gamma(t) = \lim_{t\to\infty} e^{-\rho t}\gamma(t)k(t) = 0.$$

If we compare this solution to that for the planner's problem, it is clear that for $\gamma = \theta_1$ and $\lambda = -\theta_2/\theta_1$ the solutions to the two problems are identical. Hence, by solving the social optimization problem and using an optimal and flexible emissions duty, the planner can induce profit-maximizing firms to follow the socially desirable emissions policy.

An important implication of the solution to the market problem is that if we have incomplete internalization ($\lambda \neq -\theta_2/\theta_1$), then this carries a welfare cost. The EKC, even if it is observed, then does not give any indication of the welfare cost of noninternalization across countries.

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Comment Edward B. Barbier

The paper by Jha and Whalley on the environmental regimes found in developing countries is a timely and cogently written analysis of the subject. The authors review a wide range of literature and, in doing so, cover many issues concerning the diverse environmental problems faced by developing countries.

The authors confine their analysis of this potentially broad topic to three main points. First, they argue that, although much attention has focused on the growing welfare implications of increased pollution levels in developing countries, problems of degradation (i.e., soil erosion, deforestation, overexploitation of fisheries, etc.) deserve much more attention. Second, available evidence on the economic costs to developing countries of environmental problems suggests that these costs are large, particularly with respect to the degradation problems. Finally, citing evidence from the emerging environmental Kuznets curve (EKC) and trade and environment literature, the authors point out that the relationship between growth, policy reform, and environmental quality may differ significantly depending on whether one is examining degradation or pollution problems. The authors conclude by examining a perplexing issue: If the welfare costs of many environmental externalities are so great in developing countries, why has more internalization of these costs not occurred?

I would like to make some general observations concerning these key points of the paper. First, I commend the authors for basing their paper on a distinction between conventional pollution problems and a wider, more pervasive problems of environmental degradation in developing countries. The need to make such a distinction is critical for analyzing environmental and resource issues in developing countries, because the fundamental economic and physical processes underlying degradation problems require a different approach to analyzing degradation as opposed to pollution problems (Barbier 1989; Dasgupta 1982). Unfortunately, we still need to improve our understanding of the economic aspects of environmental degradation in developing countries. As the discipline of environmental and resource economics has been developed largely in the richer or advanced industrialized countries, most of the analytical approaches are better suited to analyzing more conventional environmental

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problems such as pollution, nonrenewable depletion, and standard timber- and fishery-harvesting issues. More complex environmental problems, such as poverty, land degradation, and deforestation linkages in developing countries, clearly require a different category of analysis and one focusing in particular on the incentives of poor rural households to manage their land and other resources at their disposal (Barbier 1997a).

However, I do have some issues to raise concerning the way in which the authors distinguish environmental pollution and degradation "externalities," as indicated in table 7.1 of the chapter. In turn, these issues lead to more substantive points detailing why environmental degradation is a fundamental development problem in low-income countries.

It is important to recognize that two types of environmental externalities can occur through environmental degradation and pollution: flow externalities and stock externalities. The former is the more common type of third-party externality that is associated with conventional pollution problems, or as listed in the table, soil erosion and pesticide runoff (incidentally, the latter is really an agrochemical pollution problem and not a "soil quality" issue as table 7.1 suggests). In contrast, stock externalities arise through nonoptimal depletion of a renewable resource stock over time; that is, they represent the forgone future income associated with excessive depletion or overexploitation of a resource today. The authors seem to imply that the open-access resources of forests, fisheries, and aquifers may suffer from overexploitation, hence causing a stock externality problem. However, suboptimal depletion, degradation, or overexploitation of any type of resource stock (renewable, semirenewable, or nonrenewable) can lead to stock externalities. For example, later in the paper, the authors quote numerous estimates of the on-site cost of soil erosion across developing countries, which is essentially the stock externality problem of the forgone crop income arising from excessive topsoil and soil-fertility depletion. Yet, surprisingly, this erosion cost is not included in table 7.1. An equally surprising omission is depletion of freshwater resources, which has been cited as a critical environmental issue in developing countries in coming decades by a number of international sources, including those cited by the authors (UNDP 1998; WRI 1996).

This point may seem trivial, but it is not. The authors suggest, correctly in my view, that in developing countries resource degradation problems may be economically more significant than pollution. However, it is also possible that the most significant economic costs associated with resource degradation in developing countries take the form of the forgone income associated with resource depletion and degradation stock externalities, rather than the conventional flow externalities associated with air and water pollution, off-site impacts of sedimentation, and agrochemical runoff. This in turn implies that developing countries should be more concerned about the stock externalities arising from resource degradation, because they translate into forgone income opportunities, thus undermining economic development efforts more directly. The authors are clearly acknowledging this point, at least implicitly, by stressing that resource degradation imposes disproportionately high welfare costs on these economies. This is certainly true. However, a more fundamental reason why this is the case is that many poor countries continue to remain economically dependent on natural resources for their current development efforts, and, for the foreseeable future, efficient and sustainable management of this resource base is critical to sustaining economic development. Hence, given the economic importance of many rural renewable resources in these economies, it is not surprising that degradation of these resources imposes significantly large welfare losses and economic costs.

There is also evidence emerging from the recent literature suggesting that developing countries endowed with abundant natural resources are wasting this potential "natural capital" wealth rather than efficiently exploiting it for sustainable economic development. For example, many low-income and lower-middle-income economies—especially those displaying low or stagnant growth rates—are highly resource dependent (Barbier 1994). Not only do these economies rely principally on direct exploitation of their resource bases through primary industries (e.g., agriculture, forestry, and fishing), but also over 50 percent or more of their export earnings come from a few primary commodities. These economies tend to be heavily indebted and are experiencing dramatic land-use changes—especially conversion of forest area to agriculture—as well as problems of low agricultural productivity, land degradation, and population-carrying-capacity constraints. A recent cross-country analysis by Sachs and Warner (1995) confirms that resource-abundant countries (i.e., countries with a high ratio of natural resource exports to GDP) have tended to grow less rapidly than countries that are relatively resource poor.

Explanations as to why resource dependence may be a factor in influencing economic growth point to a number of possible fundamental linkages among environment, innovation, trade, and long-term growth that are relevant to poor economies. For example, the limitations of resource-based development have been examined by Matsuyama (1992) and Sachs and Warner (1995). Matsuyama shows that trade liberalization in a land-intensive economy could actually slow economic growth by inducing the economy to shift resources away from manufacturing (which produces learning-induced growth) toward agriculture (which does not). Sachs and Warner extend the Matsuyama model to allow for the full "Dutch disease" influences of a mineral- or oil-based economy; that is, when an economy experiences a resource boom, the manufacturing sector tends to shrink and the non-traded-goods sector tends to expand. The authors' theoretical and empirical analyses support the view that a key factor influencing endogenous growth effects is the relative structural important of tradable manufacturing versus natural resource sectors in the economy.

Of course, such models do not include the effects of resource degradation or depletion per se. However, it is fairly straightforward to demonstrate some of the possible influences of environmental-asset depletion on innovation and growth in a resource-dependent economy, as well as the role of policy and institutional failures in this process (Barbier 1999; Barbier and Homer-Dixon 1999). In terms of policy implications, this suggests that low-income countries should be pursuing a two-pronged strategy for sustained economic development. On the one hand, correcting problems of chronic policy failures, social instabilities, and poor institutions that inhibit innovation and long-term growth prospects should also enhance the capacity of these economies to reinvest the rents from natural-resource exploitation into more dynamic and advanced sectors of the economy (Barbier 1999; Matsuyama 1992; Sachs and Warner 1995). However, focusing simply on policies and institutions to foster improved innovation in the advanced economic sectors of low-income economies may not be sufficient. Because these economies are highly dependent on their natural resource base for economic growth and development over the medium term, the take-off into higher growth rates and economic development will be directly related to their ability to manage natural resources efficiently and sustainably over the medium to long term. Once again, therefore, we are back to the main issue raised by the authors of this paper: The need for developing countries to recognize the economic consequences and welfare losses arising from pervasive rural resource degradation.

A major cause of environmental degradation in developing countries is the distortion in economic incentives caused by misguided policies. Curiously, Jha and Whalley do not discuss this aspect of the problem very much in their paper. Yet there is substantial evidence emerging that policy distortions and failures are a key factor in the economic disincentives for rural households to improve long-term, efficient management at their disposal (Barbier 1997a). There are two aspects of this disincentives problem that are routinely ignored by policymakers. First, empirical evidence suggests that poorer households in rural developing regions are more constrained in their access to credit, inputs, and research and extension services necessary for investments in improved land and resource management. Poverty, imperfect capital markets, and insecure land tenure may reinforce the tendency toward short-term time horizons in production decisions, which may bias land-use decisions against long-term management strategies. Second, poverty may severely constrain the ability of poor households to compete for resources, including high-quality, productive land. In periods of commodity booms and land speculation, wealthier households generally take advantage of their superior political and market power to ensure initial access to better-quality resources in order to capture a larger share of the resource rents. Poorer households are either confined to marginal land areas where resource rents are limited or only have access to higher-quality resources once they are degraded and any rents dissipated.

Economic and sectoral policies in developing countries usually reinforce these structural disincentives for improved land management rather than mitigating them. For example, in Colombia distortions in the land market prevent small farmers from attaining access to existing fertile land (Heath and Binswanger 1996). That is, because the market value of farm land is only partly based on its agricultural production potential, the market price of arable land in Colombia generally exceeds the capitalized value of farm profits. As a result, poorer smallholders and, of course, landless workers cannot afford to purchase land out of farm profits, nor do they have the nonfarm collateral to finance such purchases in the credit market. In contrast, large land holdings serve as a hedge against inflation for wealthier households, and land is a preferred form of collateral in credit markets. Hence, the speculative and nonfarming benefits of large land holdings further bid up the price of land, thus ensuring that only wealthier households can afford to purchase land, even though much of the land may be unproductively farmed or even idle.

Thus unless better policies are designed to correct such fundamental distortions in low-income economies, the disincentives for improved land management will remain. This in turn implies that economic growth in developing countries will continue to be accompanied by rapid land-use change and resource degradation.

As the authors imply, evidence that this may be a problem is emerging from the recent EKC literature. Recently I had the privilege of editing a special journal issue on the EKC. In my review of the literature, it became clear that perhaps the only significant resource-depletion indicator that has been examined for evidence of an EKC relationship has been deforestation (Barbier 1997b). However, as Jha and Whalley have also indicated, the evidence on this relationship is mixed. Some studies suggest that deforestation conforms to the EKC hypothesis; others have found it difficult to establish a relationship between any indicator of deforestation and income (Cropper and Griffiths 1994; Shafik 1994; Antle and Heidebrink 1995; Panayotou 1995). Perhaps most worrying is that, where an EKC relationship for deforestation has been established, the real per capita income levels of virtually all developing countries in the world are well to the left of the turning-point level of income on the curve, where deforestation starts to decline. The implications of this for medium-term global deforestation trends were illustrated when colleagues and I combined an estimated EKC deforestation relationship with aggregated forecasts of income and population levels for individual countries (Stern, Common, and Barbier 1996).

Our projections show that global forest cover declines from 40.4 million square kilometers in 1990 to a minimum of 37.2 million square kilometers in 2016, and then increases slightly to 37.6 million square kilometers in 2025. However, in stark contrast, over the same period tropical forests are nearly halved from 18.4 to 9.7 million square kilometers.

On a more positive note, recent studies also demonstrate that EKCs are highly susceptible to structural economic shifts and technological changes, which are in turn influenced by policy. For example, Komen, Gerking, and Folmer (1997) point to the key role of public investments for environmental improvements in reducing environmental degradation as income levels rise, which may explain the strong EKC and even decreasing relationships found for some pollution indicators in OECD countries. Panayotou (1997) finds that improved policies and institutions in the form of more secure property rights, better enforcement of contracts, and effective environmental regulations can help to flatten the EKC for SO_2 across countries.

There are also encouraging signs that reform of environmental policy is beginning to progress in developing countries. For example, a recent review by the World Bank (1997) identifies a vast range of such environmental policy innovations that have been implemented across the globe since the 1992 Rio Environment and Development Conference to improve resource management and control pollution. Of particular importance is that many of these policies are being adopted by developing countries and that they include market-based instruments as well as removal of major policy distortions (see Huber, Ruitenbeek, and Serôa da Motta 1998). In addition, some of these reforms have been targeted at improved land and forestry management. What is more, they are being implemented as part of more general economy-wide and sector-specific reforms in these economies. This is an exciting prospect because it suggests that market-based instruments, the removal of economic disincentives, and environmental policy improvements are being considered together as important instruments in improving the link between economy and environment, thus helping to reverse the chain of unsustainable development in poorer economies.

Finally, I endorse the general view expressed by the authors that the potential welfare gains from the internalization of environmental degradation externalities in developing countries are likely to be large. Further studies of these potential gains are therefore an important priority. In support of this view, the authors cite the few available studies that attempt such valuations, including estimates of the cost of soil erosion in developing countries contained in a recent paper of mine (which is now published as Barbier 1998). However, my paper also sounds a note of caution about such cost estimates. Virtually all of the studies of the on-site costs of soil erosion in developing countries that I have reviewed have involved a very flawed methodological approach for estimating this cost. In most cases, this has led to inaccurate estimates of the income losses associated with erosion. Although this has been inevitable given the data limitation and other constraints faced by many of the studies, as I outline in my paper, it is time that we begin employing more methodologically sound approaches and thus improve our estimations of the economic costs of land degradation in developing countries. I believe this view is shared by Jha and Whalley in their paper.

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