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Environmental Protection: Help or Hurt to Developing Economies?

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Economic growth poses a dilemma. Growth in the manufacture of goods such as food, housing, health care, and transportation clearly contribute to human well-being. But the manufacture of these goods produces pollution. As pollution increases, chronic and acute health problems increase, labor productivity declines, and economic well-being falters.

A key question is whether environmental protection is worth its cost. If environmental services are worth more than the capital and labor resources that go into protecting them, then environmental protection generates more wealth than it consumes. Protection contributes to real economic growth. If environmental services are worth less, then environmental protection hurts economic well-being.

The answer to the help-hurt question depends on the relative values of environmental and non-environmental goods. Relative values depend on a nation's preferences, political structure, technologies, and wealth. A nation rich in market goods but poor in environmental quality is likely to place a high value on environmental protection. Different economic situations generate different relative values. Hence, the help-hurt question requires an empirical answer.

Market economies generate substantial value information via the prices of market goods. Environmental goods, however, are typically managed outside a market system.[2] As a result, prices for environmental goods do not emerge or are biased due to distorting influences. In the absence of a

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[2]The terms "environmental goods" and "environmental resources" are used to denote a broad set of non-market and unpriced goods. The terms denote goods as diverse as water quality, air quality, ecosystems, plant and animal species, and basic public services such as potable water and waste disposal.

positive market valuation, environmental resources are overused by polluting activities. Polluting firms receive an undue subsidy.

Two types of actions are needed to get prices and quantities right for environmental goods. The first is the creation of markets in environmental protection. Markets are created by defining transferable obligations or permits for environmental protection. Through trade, these obligations are fulfilled by the least cost producer. The market approach promises the greatest clean-up at a given economic cost. It does, however, confront difficulties in implementation due to incentives and transactions costs (Tietenberg, 1985).

The second action is to invest in an on-going capacity to value environmental services using non-market methods. Estimated values are used to assess the performance of new environmental markets, to set the direction of environmental change, and to gauge the help or harm of specific environmental investments.

This policy brief examines state-of-the-art research on non-market valuation. It describes how these methods are used, their structure, and recent experience in application. It concludes with a discussion of issues and EPAT research.

Policy Uses of Non-Market Values

Non-market values are useful at different policy levels. The first level is national economic policy. At this level, non-market values are used to modify national income accounts so that they reflect improvements and declines in environmental resources. The objective is to obtain a better index of economic well-being and avoid net loss transfers of wealth between the market and non-market sectors.

Standard gross domestic product (GDP) accounts reflect only a portion of a nation's economic productivity--the portion valued by ordinary markets. With standard accounts, a country could destroy its resource base but show an increase in national wealth (Repetto et al, 1989). The modified

accounts incorporate environmental resources as one form of national wealth. More than 15 countries are developing alternative forms of these extended accounts.

The United Nations Statistical Office endorses a satellite system of environmental accounts. The idea is a "satellite" set of money valued environmental accounts that are comparable, but separate, from the standard GDP accounts (Bartelmus et al, 1991). The satellite system is intended to encourage progress on environmental accounts without disrupting standard procedures.

Strategic benefit-cost analysis is a second use of non-market valuation. Its objective is to set priorities and make trade-offs across a range of alternative policies. For instance, strategic analysis may assess the benefits of investments in urban water supply relative to investments in improved urban air quality. Beneficial policies are then selected and put together to construct an overall policy package or agenda. Through this sorting out process, strategic analysis helps in setting policy directions. It enables a nation to distinguish policies that promise net gains in economic well-being, from those that offer only net losses.

A third use of non-market values is project level benefit-cost analysis. Project level analysis examines the benefits and costs of specific policy actions and controls. In controlling urban air pollution, project level analysis examines the benefits and costs of specific actions; actions such as changes in fuel mixtures; installation of catalytic converters; or the control of one emission versus another. Project level analysis addresses the means and methods of control once the general direction of policy is set.

The value information generated at one policy level complements the decisions at other policy levels. Each level uses values, but at different levels of precision and abstraction. Each level is supported by the same capacity to carry out non-market valuation.

Five Valuation Methods

Economics has a large toolkit for valuing non-market goods. Table 1 lists five of the most frequently used methods. The substitute service, productivity, and hedonic approaches are used where environmental goods are closely tied to the production or consumption of market goods. The travel cost method uses the costs imposed by distance to estimate the demand for unpriced goods. The constructed markets method elicits environmental values directly in carefully designed experimental and contingent markets.

The *substitute service approach* constructs environmental values using the cost of providing a substitute market service (Maler, 1974). In the simplest case, the price of an environmental service is equated to the price of a single market good--a market good that offers a similar service as the environmental good. For example, it may be appropriate to value drinking water at the cost of providing bottled water. If bottled water costs $1 per gallon, contamination of 200,000 gallons of drinking water supplies results in damages of $200,000.

In many cases, there is no single market good that provides a good substitute for an environmental service. A number of market goods may be required to avoid or avert the consequences of environmental damage. For instance, the cost of pulmonary disease may be valued by the cost of medical care and foregone wages required to return an individual to health. Added to this, are the averting costs incurred by individuals to avoid exposure to pollution. These include the filtering and conditioning costs incurred by individuals who do not become sick.

The *productivity approach* values environmental services by their impact on commercial or household production systems (Maler, 1974). Environmental services are viewed as inputs into these systems. As such, they have an observable impact on productivity. This impact may be measured by estimating a production function or by the impact of environmental quality on other inputs. The latter is often referred to as the damage function approach; it measures the damage to an input's productivity due to increase in pollution (Graves and Fishelson, 1982). Substantial efforts have been

Table 1. Valuation Methods.

Method	Description
Substitute Service Approach	Uses the cost of a substitute market service as a proxy for the environmental service.
Productivity Approach	Values an environmental service by its impact on commercial or household production.
Hedonic Approach	Values environmental quality by analysis of prices for market goods that are tied or linked to environmental quality. Land price analysis is common since land values are tied to local amenities.
Travel Cost Approach	Uses travel cost as the demand price of visiting a site. Applied especially to recreation sites.
Constructed Markets	Values environmental programs directly using survey and experimental methods.

made to measure the health damage of pollution and its subsequent effect on worker productivity (Krupnick and Portney, 1991).

The substitute service and productivity approaches measure only a portion of pollution's effect on economic well-being. The hedonic, travel cost, and constructed market approaches are intended to capture values that are closer to a demander's willingness to pay for an environmental service.

The *hedonic approach* extracts the environmental values that are implicit in market prices (Bartik and Smith, 1987; Hoehn et al, 1987). It relies on the existence of market sales that are in some way tied to environmental quality. For instance, the price of housing depends on structural features such as square footage, number of rooms, and age. It also depends on neighborhood factors such as schools and crime. Air quality is also an important neighborhood factor in large urban areas where air quality varies spatially. The hedonic technique uses statistical procedures to separate that portion of price that depends on a given factor. The hedonic technique has been applied to services such as air quality and odors, water quality, workplace hazards, noise, food safety, and landfill hazards.

The *travel cost approach* values a recreation or similarly defined site by the time and money that individuals spend to get there (McConnell, 1985). The approach uses travel cost as the price of distance--as the price of access to a given site. The number of visits declines with an increase in the distance between a site and a visitor population. The distance-visitation relationship is used to estimate a demand curve for the site. The demand curve is then used to estimate marginal values per visit or to estimate the total value of the site. Recent applications extend the single-site travel cost method to systems of recreation sites and to site characteristics such as water and air quality.

The *constructed market approach* values environmental services directly (Carson, 1991). Experimental markets are constructed to offer an individual the opportunity to pay real dollars in exchange for an environmental service. For instance, an experimental market may offer a respondent the opportunity to protect a special ecosystem by making real payments into a land purchase fund. In contrast, contingent markets elicit what an individual would do, contingent upon a described program

and program cost. For instance, a survey may be constructed to determine whether individuals would vote for or against a program to improve air quality or install sewers. Respondents would be asked to vote for or against the program at a specified household cost. Econometric methods are used to extract willingness to pay from the pattern of contingent votes.

Flexibility is the hallmark of the constructed markets approach. Not constrained to existing markets, they can be adapted to fit almost any environmental service. This flexibility is deceptive since the wrong design choices can lead to fundamental errors in application. Incentives for truthful valuation are a concern (Hoehn and Randall, 1987). Communication is problematic; technical descriptions must be translated into terms that ordinary citizens can understand. This problem of translation is compounded by cultural differences. Control of these confounding effects requires a commitment of resources for developing and testing market prototypes (Desvousges and Smith, 1990). Inadequate control results in unreliable, meaningless results (Hoehn, 1987).

Each of the five valuation methods has its strengths and weaknesses. In this light, it is best to view each method as contributing a piece of evidence. By applying more than one method, a body of cross-corroborating evidence can be built up regarding the value of an environmental good or service.

Non-Market Values in National Accounts

The exclusion of non-market goods and services from national accounts has been a concern since their inception. This concern deepened in the 1960's as national accounting methods were adopted in countries with substantial subsistence economies. Where subsistence activities are routine, a large portion of the economy is unpriced. A net loss transfer of resources from subsistence to the commercial sectors could easily show up as a net gain in measured national income. This bias led the United Nations to develop and recommend procedures for pricing subsistence activities [van Heemst, 1984).

The first attempts to incorporate environmental resources in national accounts were aimed at stocks of natural resource commodities. These included stocks of oil, forests, soil, and fish. Standard accounts recognize the value of these resources only when they are extracted or harvested. The income from extraction or harvest is noted in standard accounts, but not the corresponding depreciation in the value of the remaining stock.

Several recent studies estimate depreciation for resource commodities such as oil and forest stocks using the substitute service approach. At the margin, a lower bound on the value of standing trees is their value as lumber.[3] Depreciation is the difference between the current market value of the resource stock and the market value of the stock in the next time period. In Indonesia, standard accounting procedures show that GDP growth from 1971 to 1984 averaged 7.1 percent per year. This growth rate drops to 4 percent per year after deducting for depreciation in only three resources--oil, forests, and soil. (Repetto, et al, 1989). A similar analysis in Costa Rica showed a 6 percent difference between the apparent and real GDP growth rates (Solorzano et al., 1991).

Two recent studies go beyond resource commodities to incorporate unpriced environmental goods such as air and water quality. The Mexican government and the World Bank developed prototype accounts that include conventional market goods, resource commodities, and unpriced environmental goods. These accounts indicated that the cost of environmental decay reduced Mexican national income by 13 percent. Capital accounts showed that a 13 percent rate of net investment in ordinary capital was offset by a decrease of 15 percent in environmental capital. This means that Mexican national wealth was actually declining at 2 percent per year (van Tongeren and Schweinfest, 1991). This pattern of investment is not sustainable.

In a second experiment, Daly and Cobb (1989) extended the national accounts for the U.S. economy to a broad range of environmental goods, including air quality, water quality, wetlands,

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[3]Valuing forests at their timber value overlooks other valuable services that forests provide.

noise, non-market household goods, and urban congestion. This extension drew on a research literature that included all five of the valuation methods listed in Table 1. Daly and Cobb called their extended measure of national income an index of sustainable welfare (ISW).

Figure 1 shows per capita GNP and per capita ISW for 1950 through 1986. Both GNP and ISW increased markedly during the time period but GNP at a much faster rate than ISW. The result is an absolute divergence between GNP and ISW. In 1950, ISW is 30 percent less than GNP. By 1986, ISW is 50 percent less than GNP.

These prototype studies are experimental. The framework and methods they used require further refinement. They do indicate, however, that environmental quality has an empirically significant impact on national economic performance and well-being. Standard accounts ignore this impact. The omission allows a nation to be blindsided by environmental decay. Extended national accounts are an important step toward understanding and managing the real economic tradeoffs.

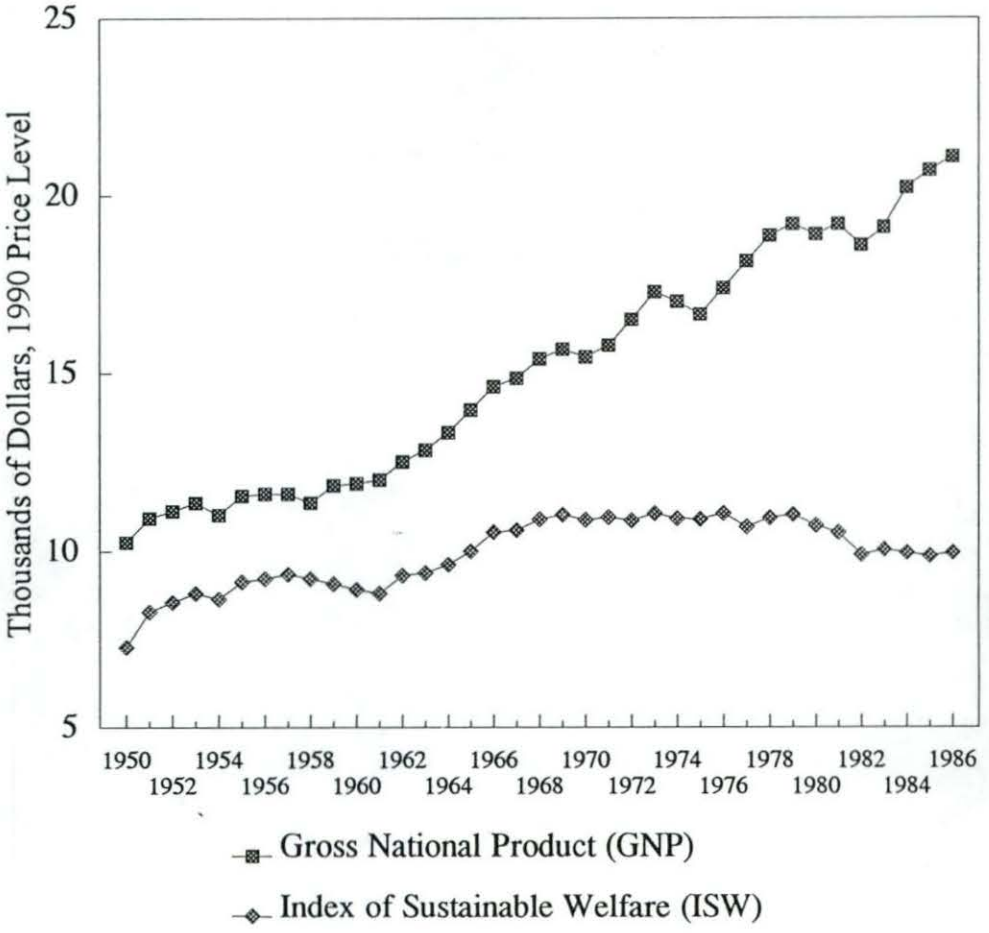
Non-Market Values in Strategic Analysis

Strategic benefit-cost analysis is motivated by the economic consequences of environmental investments. Ill-advised investments waste a nation's resources. Strategic analysis supports informed policy choices through the ex ante analysis of alternative environmental investments.

Strategic analysis is limited by the existing capacity for non-market valuation. In the U.S., non-market valuation developed steadily since the 1960's. This research base supported the first examples of strategic analysis in the late 1970's. The prototype analyses included Peskin and Seskin (1975), Ridker and Watson (1980), and Freeman (1982).

Freeman (1982) analyzed the benefits and costs of U.S. air and water pollution control programs. The analysis did not attempt to produce new value estimates. Instead, it integrated the existing research in a prototype strategic framework. The framework defined benefit categories, identified knowledge gaps, and gave a preliminary idea of aggregate benefits and costs.

Figure 1. United States: Per Capita GNP and ISW, 1950-86



Source: Daly and Cobb, 1989.

Table 2 lists Freeman's benefit-cost categories and estimates. Benefit estimates for agriculture, fisheries, and materials damage were produced using research based on the substitute service and productivity approaches. Increased agricultural productivity was estimated to be $0.6 billion due to air pollution control. No agricultural estimate was made for water quality. Water quality improvements to commercial fishing were $1.6 billion. Materials benefits in the form of reduced soiling, maintenance, and treatment resulted in benefits of $7.4 billion due to air quality and $3.6 billion due to water quality improvements.

Health, recreation, aesthetic, and residential property benefits were based on research using the travel cost, hedonic, and constructed market approaches. Health benefits of $34 billion for air quality were the largest single source of benefits. Health, recreation, and aesthetic benefits totaled $13.6 for water quality. Residential property values added an additional $1.4 billion to the benefits of air quality improvement.

The estimates indicate that annual air pollution benefits exceed costs by more than $10 billion. In contrast, the net benefits water pollution control are negative. Several alternatives might be considered. One possibility is an expansion of air pollution control and a cutback on water pollution control expenditures. A second would be to identify specific policy actions to enhance benefits and reduce costs.

Recent analyses at the strategic level improve on conventional benefit cost analysis. They explicitly model the demand and supply conditions within an economy using a computable general equilibrium (CGE) framework (Jorgenson and Wilcoxen, 1990). The CGE framework accounts for the direct effects of environmental policy as well as the indirect effects that arise as individuals within an economy respond to changing prices. In addition, the CGE framework allows one to better distinguish between marginal versus total benefits.

Table 2. Annual Benefits and Costs of Air and Water Pollution Control, United States (in billions of U.S. dollars, 1990 Price Level)[a].

Benefit-Cost Category	Air Pollution Control	Water Pollution Control
Benefit Categories:		
Agriculture	0.6	-
Fisheries	-	1.6
Materials Damage	7.4	3.6
Health	34.0	2.0
Recreation	-	9.2
Aesthetic	-	2.4
Residential Property	1.4	-
Total Benefits	43.4	18.8
Total Control Costs	33.2	21.4

[a]Estimates are from Freeman (1982). A dash indicates that a dollar value was not estimated for the benefit category.

Non-Market Values in Project Analysis

Project level analysis extends conventional benefit cost procedures to the non-market sector. It is increasingly common in development decisions (Vincent et al, 1991). Two recent studies illustrate the use of the constructed markets approach in project level analysis.

A World Bank study in Brazil estimated households' willingness to pay (WTP) to hook up to a centralized water system (Briscoe et al, 1990). Value data were obtained using in-person surveys and contingent valuation. The valuation question asked, "If you were required to pay X cruzados per month for a connection, would you choose to connect to the system or would you prefer to use the alternative source?"

Average willingness to pay for a yard connection was 100 cruzeiros or about 2.3 percent of household income. Variation in willingness to pay across households, however, meant that only a subset of households would connect at a charge sufficient to cover the cost of the hook-ups. Financial viability could be attained, however, by providing different services at different prices. One financially viable alternative was to provide in-yard taps at a price high enough to cover the cost of public taps for lower income households.

A similar contingent valuation study estimated willingness to pay for improved sanitary sewers in Kumasi, Ghana (Whittington et al., 1991). The study is notable for the extensive effort made to understand residents' attitudes toward the existing, decentralized sanitation system. These attitudes were critical in interpreting the willingness to pay results.

In aggregate, a centralized, conventional sewer system with in-home water closets failed the benefit cost test. Benefits were only 5 to 20 percent of costs. A perceived lack of reliability was critical. Residents viewed water closets as unreliable, requiring both a reliable sewer system as well as a reliable water system. In contrast, benefits exceeded costs for a decentralized system based on sanitary, vented latrines. Via this second option, a major improvement in sanitation could be had with no significant burden on scarce governmental funds.

Research Issues

Non-market valuation fills a significant gap between economic and environmental policy. Through national accounting and strategic analysis, it helps assess the most beneficial direction for environmental policy. Through project level analysis, it identifies specific, beneficial actions. Non-market valuation places environmental decisions on an equal footing with conventional economic policy.

A capacity for non-market valuation and analysis is essential if a country is to avoid costs of uninformed policy. This seems doubly true in the least developed nations that have the least resources to waste. Countries with common resources and problems may choose to support non-market analysis at the regional level in order to further conserve resources.

Public investment in a program of non-market valuation might evolve through three stages. At the first stage, an inventory of quantity and quality data is constructed for priority issues. Given the work cited above, health effects are certainly a priority issue. Resource commodities and special resource situations--endangered biomes and species--are also critical. As data are assembled, services are valued using the substitute service and productivity approaches.

At the second stage, priorities and knowledge gaps are reassessed given the initial valuations. Non-market value data are incorporated into extended national accounts, strategic analysis, and project analysis. Studies are implemented to value priority services using the hedonic, travel cost, and constructed market approaches.

At the third stage, non-market valuation is an integral, on-going part of environmental policy. Non-market values are updated as new studies are completed. Economic and environmental decisions are made in view of the estimated tradeoffs. Their success or failure is tracked by extended national accounts.

EPAT Research and Assistance

EPAT/MUCIA has the capacity to support a full range of non-market valuation efforts. Cooperating researchers are expert in applications that range from health effects to biodiversity. Inquiries about personnel and publications may be made to the Chief of Party or to any of the five research team leaders.

Reprints of this publication may be obtained directly from the author. An extended report on these issues will be available from the author in March, 1993.

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