E P A T / M U C I A

POLICY BRIEF

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When Prices Miss the Mark: Methods for Valuing Environmental Change

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Introduction

Economic growth poses a dilemma. Growth in the manufacture of goods contributes to human well-being, but also produces pollution. As pollution increases, health problems increase, labor productivity declines, and economic well-being falters.

A key question is whether environmental protection is worth its cost. If the provision of environmental goods and services[1] over time is worth more than the resources that go into protecting them, then environmental protection helps achieve real economic growth. If the provision of environmental goods and services over time is worth less, then environmental protection hurts economic well-being. This economic help or hurt of environmental protection depends on the relative values of environmental and non-environmental goods and services.

Market economies generate substantial value information which is reflected in the prices of market goods. Many environmental goods and services, however, are typically managed outside--or are only partially managed through--a market system. As a result, prices for many environmental goods and services do not emerge or are biased due to distorting influences. In the absence of a positive market valuation, environmental resources will be overused.

Two types of actions may help to get prices and quantities right for environmental goods and services. The first is the creation of markets for environmental goods and services. This approach promises economically efficient clean-up and preservation of environmental resources at a given economic cost. It does, however, confront difficulties in implementation.[2]

The second action is to invest in an ongoing capacity to value environmental goods and services using non-market methods. Estimated values are used to assess the performance of new markets for environmental goods and services, 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.

Policy Uses of Non-Market Values

Non-market values are useful at different policy levels. Information generated for use at one level complements decisions at other policy levels. The first use is at the national and regional economic policy level. Here, non-market values may be 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.

Non-market valuation places economic and environmental decisions on a more equal footing.

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

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 improved urban air quality. Beneficial policies are then selected and put together to construct an overall policy package or agenda. Strategic analysis helps in setting policy directions that promise net gains in economic well-being.

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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; or the control of one emission versus another. It addresses the means and methods of control once the general direction of policy is set.

Five Valuation Methods

Economics has a large toolkit for estimating the values of non-market goods and services. Table 1 lists five of the most frequently used methods.

The *substitute service approach* constructs environmental values using the cost of providing a substitute market service.[4] In the simplest case, the price of an environmental good or service is equated to the price of a similar market good or service. 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 an adequate substitute for an environmental good or service. A number of market goods may be required to avoid or avert the consequences of environmental damage. For instance, the cost of lung disease may be valued by the cost of medical care and lost wages. Added to this are the costs incurred by individuals to avoid exposure to pollution.

The *productivity approach* values environmental resources by their impact on commercial or household production systems.[5] Environmental goods and services are viewed as inputs into these systems. Their impact on productivity 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 an increase in pollution, for example.[6] Substantial efforts have been made to measure the impact pollution has had on worker health and productivity.[7]

These two approaches measure only a portion of pollution's effect on economic well-being. The following three approaches are intended to capture values that are closer to a consumer's willingness to pay for an environmental good or service.

The *hedonic approach* extracts the environmental values that are implicit in market prices.[8] 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 (size, age) and neighborhood factors (schools, 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 the portion of price that depends on a given factor. It has been applied to services such as air and water quality, workplace hazards, noise, food safety, and landfill hazards.

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 and 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.

The *travel cost approach* values a recreation, or similarly defined, site by the time and money that individuals spend to get there.[9] The approach uses travel cost as the price of distance or 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. This curve is then used to estimate marginal values per visit or the total value of the site.

The *constructed market approach* values environmental goods and services directly.[10] Experimental markets are constructed to offer an individual the opportunity to pay real dollars in exchange for an environmental good or service. For instance, such a 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 install sewers 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. Because this approach is not constrained to existing markets, it can be adapted to fit almost any environmental resource. However, this flexibility is deceptive since the wrong design choices can lead to fundamental errors in application. Control of confounding effects requires a commitment of resources for developing and testing market prototypes.[11] Inadequate control results in unreliable, meaningless results.[12]

Each of the five methods has its strengths and weaknesses. Each may be subject to error and bias in application. A thorough understanding of each is essential for correct interpretation. Each method takes and gives a somewhat different perspective of a non-market good or service. It is best to apply more than one method and to view each estimate as a piece of evidence. The result is a body of value evidence that can be cross-checked for logical consistency and contradictions.

Non-Market Values and National Accounts

The exclusion of non-market goods and services from national accounts has been a concern since their first widespread use in the 1940s and 50s. This concern deepened in the 1960s 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.[13]

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The first attempts to incorporate environmental resources in national accounts were aimed at stocks of natural resource commodities such as oil, forests, soil, and fish. Standard accounts recognize the value of these resources only when they are extracted or harvested; the income from this is noted in standard accounts. But the corresponding depreciation in the value of the remaining stock is not taken into consideration.

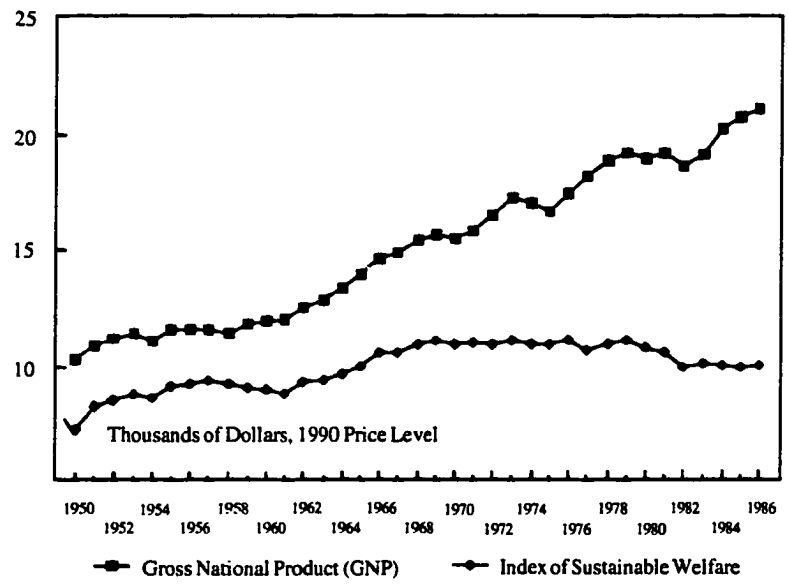
Several recent studies estimate depreciation for resource commodities, such as oil and forest stocks, using the substitute service approach. Depreciation is the difference between the current market value of the resource stock and the market value of the stock in the next time period. In Indonesia, standard accounting procedures show that GDP growth (1971-1984) averaged 7.1% per year. This growth rate drops to 4% after deducting for depreciation in only three resources--oil, forests, and soil.[14] A similar analysis in Costa Rica showed a 6% difference between the apparent and real GDP growth rates.[15]

Two recent studies go beyond resource commodities to incorporate unpriced environmental goods and services 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 and services. These accounts indicated that the cost of environmental decay reduced Mexican national income by 13%. Capital accounts showed that a 13% rate of net investment in ordinary capital was offset by a decrease of 15% in environmental capital. This means that Mexican national wealth was actually declining at 2% per year.[16] This pattern of investment is not sustainable.[17]

In a second experiment, Daly and Cobb[18] extended the national accounts for the U.S. economy to a broad range of environmental goods and services, including air and water quality, wetlands, noise, 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 the U.S. from 1950 to 1986. Both GNP and ISW increased markedly during the time period but

Figure 1 United States Per Capita GNP and ISW (U S 1990. $1.000)



Source: Daly and Cobb, 1989.

GNP at a much faster rate than ISW. The result is an absolute divergence between GNP and ISW.

These prototype studies are best viewed as experimental. The framework and methods they use require further scrutiny and refinement. The studies do suggest, however, that environmental quality has an empirically significant impact on economic performance. Standard accounts ignore this impact. This omission may allow a nation to be blind-sided by environmental decay. Extended accounts offer one framework for considering the real economic tradeoffs.

Research is needed to extend the present studies. The existing cases fail to address human capital, institutional assets, or technological change. The exclusions mean that we cannot determine whether the measured natural resource depletion is offset by investments in schools, institutions, or technological innovation. The present studies are therefore unhelpful when it comes to critical developmental tradeoffs--such as whether it makes sense to forego an investment in schools in order to save a forest. A true measure of sustainability accounts for all productive assets. Without broad coverage, the accounts are limited to sectoral issues.

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 studies and techniques have developed steadily since the 1960s. This research base supported the first examples of strategic analysis in the late 1970s.[19]

Freeman[20] analyzed the benefits and costs of U.S. air and water pollution control programs. The analysis integrated 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. 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. Estimated health, recreation, aesthetic, and residential property benefits were based on research using the travel cost, hedonic, and constructed market approaches.

These estimates indicated that annual air pollution benefits exceed costs by more than $10 billion. The health benefit estimate of $34 billion for air quality was the largest single source of benefits. In contrast, the net benefits of water pollution control are negative. Several alternatives might be considered. One option 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.

Non-Market Values in Project Analysis

Project-level analysis extends conventional benefit-cost procedures to the non-market sector. This extension is increasingly common in development decisions.[21] 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.[22] Value data were obtained using in-person surveys and contingent valuation. The valuation question asked, "If you were required to pay

X cruzeiros per month for a connection, would you choose to connect to the system or would you prefer to use the alternative source?"

Average WTP for a yard connection was 100 cruzeiros or about 2.3% of household income. Variation in willingness to pay, 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 alternative was to provide in-yard taps at a price high enough to cover the cost of public taps for lower income households.

Non-market valuation can help assess development choices involving unpriced goods and services.

A similar contingent valuation study estimated willingness to pay for improved sanitary sewers in Kumasi, Ghana.[23] In aggregate, a centralized, conventional sewer system with in-home water closets failed the benefit-cost test. Benefits were only 5% to 20% of costs. A perceived lack of reliability was critical. Residents viewed water closets as unreliable, requiring both reliable sewer and water systems. In contrast, benefits were larger than 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.

Policy Implications

Non-market valuation can help assess development choices involving unpriced goods and services. Unpriced and partially priced goods and services include municipal water and sewage systems, health care services, and public transportation systems. Non-market valuation is used to estimate the demands for these goods and services. Resource issues include the destruction of wetlands, overuse of a common aquifer, the health costs of airborne lead and other pollutants, and the foregone tourism due to the pollution of rivers and beaches and the destruction of coral reefs. In these cases, non-market valuation helps make tradeoffs between the priced and unpriced uses of a resource.

Non-market valuation places economic and environmental decisions on a more equal footing. It has a proven record in extending the scope and usefulness of project-level benefit-cost analysis. On an experimental and trial basis, it may be used with strategic analysis or extended accounts to assess broad policy directions.

Public investment in non-market valuation might evolve through three stages. At a first stage, project-level studies are conducted to assist in key development decisions. Valuation approaches are chosen to fit the specific needs, budget, and data limitations of the project-level studies. The studies contribute to a growing inventory of quantity, quality, and value data for unpriced goods and services.

At a second stage, knowledge gaps and priorities are assessed given the accumulated data and experience. Valuation studies are carried out to fill in gaps. Special studies may be designed to compare the performance of alternative methods. Experiments may be funded to refine and test the policy usefulness of strategic analysis and extended accounts.

At a third stage, non-market valuation is an integral, on-going part of environmental and development policy. Values are updated as new studies are completed. Economic and environmental decisions are made in view of the estimated tradeoffs. The success and failure of these tradeoffs may be tracked by extended accounts.

At each stage, practitioners and their clients need to be aware of the state-of-the-art. At present, non-market

Table 2 Annual Benefits and Costs of Air and Water Pollution Control United States (in billions U S $ 1990 Price Level)

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

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

valuation is an evolving and difficult area of research. It requires specialized skills and care in estimation and interpretation. A misapplied method can be worse than useless--it can mislead rather than inform. Time and a healthy skepticism may help a country to build its technical capacity and to benefit from the practical uses of any given method.

Notes

[1] The terms "environmental goods and services" 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.

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[16] **van Tongeren, J. and S. Schweinfest.** 1991. *Integrated Environmental and Economic Accounting: A Case Study for Mexico.* Environment Working Paper 50. Washington, D.C.: The World Bank.

[17] The study did not try to measure investments in human capital, institutions, and technological innovation. The unmeasured investments in these assets may have offset the measured changes in conventional and environmental capital.

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