

Nature's Numbers

Expanding the National Economic Accounts to Include the Environment

William D. Nordhaus and Edward C. Kokkelenberg, *Editors*

Panel on Integrated Environmental and Economic Accounting

Committee on National Statistics

Commission on Behavioral and Social Sciences and Education

National Research Council

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PANEL ON INTEGRATED ENVIRONMENTAL AND ECONOMIC ACCOUNTING

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documents with us, thus giving the panel a broader perspective concerning the problems we considered. We are particularly thankful for insights provided by Ann Harrison of the Organization for Economic Cooperation and Development and Henry Neuberger of Her Majesty's Government, United Kingdom.

This report, the collective product of the entire panel, reflects the dedication and commitment of its individual members. All of the panel members participated in many meetings and discussions and in reviewing drafts and contributing sections to the final report. In addition, John Tilton led a subpanel on minerals and John Reilly and Henry Peskin led a subpanel on renewable and environmental resources. Clark Binkley was particularly helpful in developing the sections of the report on forestry, and Martin Weitzman was instrumental in developing the material on sustainability.

The panel was extraordinarily lucky to have the assistance of Edward Kokkelenberg, the study director, who had responsibility for organizing and coordinating panel and subpanel meetings, gathering much of the written material, attending the London Group conference, arranging for consultants, and preparing the report. Without his skills and dedication, the report could not have been produced in the time available.

The panel was established under the auspices of the Committee on National Statistics. Miron Straf, director of the committee, was instrumental in developing the study and providing guidance and support to the panel and staff. The committee, under the chair first of Norman Bradburn and later of John Rolph, had the responsibility for establishing the panel and monitoring its progress. Deputy director Andrew White helped us in the final stages to develop sharp recommendations and navigate the requirements of the National Research Council.

Other members of the staff included Joshua Dick, Cassandra Shedd, Jennifer Thompson, and Anu Das; they provided excellent administrative, editorial, and research support for the study and the report. We also thank Rona Briere, who helped us improve the report through technical editing. To all we are most grateful.

Our report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

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of British Columbia (emeritus); Thomas C. Schelling, School of Public Affairs, University of Maryland; Burton H. Singer, Office of Population Research, Princeton University; and Robert M. Solow, Department of Economics, Massachusetts Institute of Technology.

Although the individuals listed above have provided constructive comments and suggestions, it must be emphasized that responsibility for the final content of this report rests entirely with the panel and the National Research Council.

This report and its many antecedents over the last two decades owe their existence, high quality, and purpose to the pioneering work of the late Robert Eisner of Northwestern University. Professor Eisner was a member of the panel and gave us his wisdom and guidance throughout our deliberations. Bob Eisner died in November 1998 after the report was completed. I speak for the panel in saluting his many contributions; we will miss him.

William D. Nordhaus, Chair

Panel on Integrated Environmental and Economic Accounting

The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

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Executive Summary

This report addresses the question of whether the U.S. National Income and Product Accounts (NIPA) should be broadened to include activities involving natural resources and the environment. The NIPA are the most important measures of overall economic activity for a nation. They measure the total income and output of the nation; their purpose is to provide a coherent and comprehensive picture of the nation's economy.

A central principle underlying the national accounts is to measure production and income that arise primarily from the market economy. However, the NIPA's focus on market activities has raised concerns that the accounts are incomplete and misleading because they omit important nonmarket activities, such as nonmarket work, the services of the environment, and human capital. In response to these concerns about standard measures of economic activity, private scholars and governments have endeavored to broaden the national accounts in many directions. Most recently, attention has focused on extending the accounts to include natural resources and the environment. The guiding principle in extended national accounts is to measure as much economic activity as is feasible, whether that activity takes place inside or outside the boundaries of the marketplace.

Intensive work on environmental accounting began in the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce in 1992. Shortly after the first publication of the U.S. Integrated Environmental and Economic Satellite

Accounts (IEESA) in 1994, Congress directed the Commerce Department to suspend further work in this area and to obtain an external review of environmental accounting. A panel working under the aegis of the National Research Council's Committee on National Statistics was charged to "examine the objectivity, methodology, and application of integrated environmental and economic accounting in the context of broadening the national accounts" and to review "the proposed revisions . . . to broaden the national accounts." This report presents the panel's findings and recommendations.

INTEGRATED ENVIRONMENTAL AND ECONOMIC ACCOUNTING AND ITS BENEFITS TO THE NATION

BEA developed the IEESA because of the growing importance of environmental accounting both in the United States and abroad. Better natural-resource and environmental accounts have many benefits. They provide valuable information on the interaction between the environment and the economy; help in determining whether the nation is using its stocks of natural resources and environmental assets in a sustainable manner; and provide information on the implications of different regulations, taxes, and consumption patterns.

More generally, augmented NIPA that encompass market and nonmarket environmental assets and production activities would be an important component of the U.S. statistical system, providing useful data on resource trends. The rationale for augmented accounts is solidly grounded in mainstream economic analysis. BEA's activities in developing the environmental accounts are consistent with an extensive domestic and international effort both to improve and to extend the NIPA.

The panel concludes that extending the U.S. national income and product accounts (NIPA) to include assets and production activities associated with natural resources and the environment is an important goal. Environmental and natural-resource accounts would provide useful data on resource trends and help governments, businesses, and individuals better plan their economic activities and investments. The rationale for augmented accounts is solidly grounded in mainstream economic analysis. BEA's activities in developing environmental accounts (IEESA) are consistent with an extensive domestic and international effort to both improve and extend the NIPA. (Recommendation 5.1)¹

There are two possible approaches to developing nonmarket and environmental accounts: a phased and a comprehensive approach. BEA's proposal for developing the IEESA envisions use of the phased approach, adding satellite accounts for natural-resource and environmental assets in three phases starting with subsoil mineral assets, expanding to renewable and other natural resources such as timber in forests, and only then addressing nonmarket environmental assets such as clean air and water. Under the comprehensive approach, a broad set of nonmarket accounts would be developed in parallel with the near-market accounts. BEA would develop accounts not only for the minerals and near-market sectors, but also for nonmarket activities and assets.

If the phased approach is undertaken, a useful initial step would be to refine the initial estimates of subsoil minerals. Constructing forest accounts, focusing initially on timber, is a natural next step for integrated environmental and economic accounts. Other sectors that should be high on the priority list are those associated with agricultural assets, fisheries, and water resources.

Although recognizing the value of the phased approach, the panel finds that developing comprehensive nonmarket accounts is of the greatest substantive

importance for augmented accounting and for policy purposes. The panel does not, however, underestimate the challenges involved in developing nonmarket accounts. The process will require resolving major conceptual issues, developing appropriate physical measures, and valuing the relevant flows and stocks.

The panel concludes that developing a set of comprehensive nonmarket economic accounts is a high priority for the nation. Developing nonmarket accounts to address such concerns as environmental impacts, the value of nonmarket natural resources, the value of nonmarket work, the value of investments in human capital, and the uses of people's time would illuminate a wide variety of issues concerning the economic state of the nation. (Recommendation 5.2)

At present, BEA does not plan to redefine the core NIPA to include flows or investments in natural resources and the environment. Natural-resource and environmental flows will instead be recorded in satellite or supplemental accounts. Satellite environmental accounts serve the basic functions of a national accounting system: they provide the raw material needed by policy makers, businesses, and individuals to track important trends and to determine the economic importance of changes in environmental variables. In addition, developing environmental satellite accounts allows experimentation and encourages the testing of a wide variety of approaches.

The panel recommends that the core income and product accounts continue to reflect chiefly market activity. Given the current state of knowledge and the preliminary nature of the data and methodologies involved especially in areas related to nonmarket activities developing satellite or supplemental environmental and natural-resource accounts is a prudent and appropriate decision. (Recommendation 5.5)

BEA'S RESUMPTION OF NATURAL-RESOURCE AND ENVIRONMENTAL ACCOUNTING

Given the importance of augmented accounts, the panel is concerned that, particularly since BEA's work in this area stopped in 1994, the United States has fallen behind in developing environmental and other augmented accounting systems. The United States has in place today only the barest outline of a set of natural-resource and environmental accounts, with numerical estimates limited to subsoil mineral assets. This lag has occurred even as the importance of the environment has become increasingly obvious.

The panel recommends that Congress authorize and fund BEA to recommence its work on developing natural-resource and environmental accounts, and that BEA be directed to develop a comprehensive set of market and nonmarket environmental and nonenvironmental accounts. (Recommendation 5.3)

ACCOUNTING FOR SUBSOIL MINERAL ASSETS

The first phase of BEA's work on integrated environmental and economic accounts, published in 1994, resulted in a full and well-documented set of subsoil mineral accounts with useful estimates of the value of mineral reserves. This effort reflects a serious and professional attempt to value subsoil mineral assets and assess their contribution to the U.S. economy. BEA's methods are widely accepted and used by other countries endeavoring to extend their national income accounts, and BEA has relied on sound and objective measures in developing these prototype accounts. BEA should be commended for its initial efforts to value subsoil mineral assets in the United States.

The panel's review uncovered a number of issues that arise in the valuation of mineral resources. The most important issues for further study are the value of mineral resources that are not proven reserves, the impact of ore-reserve heterogeneity on valuation calculations, the distortions introduced by associated capital and production constraints, the volatility in the value of mineral assets introduced by short-run price fluctuations, and the differences between the market and social value of subsoil mineral assets.

From a substantive point of view, the subsoil mineral accounts provide a useful summary of trends in the value of subsoil mineral assets. Two important findings from the initial IEESA are that subsoil assets constitute a relatively small portion of total U.S. wealth and that real proven mineral wealth (resources and associated assets) has remained roughly constant over time. These are important and interesting results that were not well established before BEA developed the subsoil mineral accounts.

While subsoil assets currently account for only a small share of total wealth in the United States, and their depletion does not appear to pose a threat to sustainable economic growth, this situation could change in the future. A good system of accounts could address the widespread concern that the United States is depleting its mineral wealth and shortchanging future generations. By properly monitoring trends in resource values, volumes, and unit prices, the national economic accounts can identify the condition of important natural resources, not only at the national level, but also at the regional and state levels. Better measures would also allow policy makers to determine whether additions to mineral reserves and capital formation in other sectors are offsetting depletion of valuable minerals. Development of reserve prices and unit values would help in assessing trends in resource scarcity. Comprehensive mineral accounts would provide the information needed to develop sound public policies for mineral resources, including minerals on public lands.

Other countries and international organizations are continuing to develop accounts that include subsoil assets and other natural and environmental resources. The United States has historically played a leading role in developing sound accounting techniques, exploring different methodologies, and introducing new approaches. Unfortunately, the United States has lagged behind other countries in developing natural-resource and environmental accounts since BEA's work in this area stopped. Resumption of BEA's work on augmented accounting would allow the United States to exercise leadership in the manner in which such accounts are developed internationally.

Improved mineral accounts at home and abroad would provide substantial economic benefit to the United States. Improved accounts would be particularly useful for those sectors in which international trade is important. Indeed, as is evident from recent cataclysmic events in financial markets such as the Mexican crisis of 1994-1995 and the financial crises of East Asian countries in 1997-1998, U.S. interests suffer when foreign accounting standards are poor. The United States is a direct beneficiary of better accounting and reporting abroad. Better international mineral accounts would improve understanding of resource consumption and production trends abroad and help in assessing the likelihood of major increases in the prices of oil and other minerals of the kind witnessed in the 1970s. Improved accounts at home and abroad would allow governments and the private sector to better forecast and cope with the important transitions in energy and materials use that are likely to occur in the decades ahead. To the extent that the United States depends heavily on imports of fuels and minerals from other countries, it would benefit from better mineral accounts abroad because the reliability and cost of imports can be more accurately forecast when data from other countries are accurate.

and well designed.

The panel recommends that BEA develop and maintain a set of accounts for domestic subsoil mineral assets. (Recommendations 3.9 and 3.10)

ACCOUNTING FOR RENEWABLE AND ENVIRONMENTAL RESOURCES

BEA had not yet begun developing its accounts for renewable and environmental resources when Congress suspended the agency's work on environmental accounting. Environmental accounting is a useful way to represent interactions between market activity and the environment. There are three major types of interactions: additions and depletions of natural resources that occur when minerals and energy resources are discovered or mined, when timber grows or is harvested, and when groundwater is withdrawn or replenished; alterations in the quality of the natural environment that occur when the composition of air, water, or soil changes; and expenditures made to reduce the effect of economic activities on the environment. The main value of natural-resource and environmental accounting is to illuminate the full role played by these resources in the economy.

The panel recommends that BEA continue its work on developing accounts for renewable natural resources and the environment. (Recommendation 4.1)

Valuing environmental goods and services requires distinguishing between private goods and public goods. Private goods can be provided separately to different individuals with no external benefits or costs to others; public goods have benefits or costs that are spread indivisibly among the entire community or even the entire planet. Price data are relatively reliable for private market goods, such as the timber produced from forestry assets. Values for near-market goods such as freely collected firewood can be constructed by comparing the near-market goods with their market counterparts. Techniques for valuation of public goods are still under development. Some techniques such as hedonic-price or travel-cost studies rely on behavioral or market-based estimates; while these estimates are subject to significant measurement problems, they are conceptually appropriate in economic accounts. Other techniques, such as contingent valuation, are not based on actual behavior, are highly controversial, and are subject to potential measurement errors. An important issue here (as it is throughout the federal statistical system) is developing measures of accuracy, both for satellite accounts and the main accounts.

For valuation, BEA should rely whenever possible on market and behavioral data. However, novel valuation techniques will be necessary for the development of a comprehensive set of nonmarket accounts. (Recommendation 5.7)

Quantitative data on many market and near-market activities are at present comparatively adequate. Quantitative data for natural resources are often reliable because in many cases there are well-established conventions for their measurement. Quantitative data on some near-market activities, such as the collection of fuel wood for private use and recreational fishing, are conceptually straightforward, and many of these data are currently collected by federal agencies. Quantitative data on other marketable goods, such as stocks of commercial fish, could be improved substantially. The measurement of quantities for nonmarket goods and services, particularly those that have public-good characteristics, suffers from severe methodological difficulties and insufficient data. There are relatively good physical data on emissions of many

residuals from industrial and human activities, but there is very little systematic monitoring of human exposures to most harmful pollutants. The data on many environmental variables are currently poorly designed for the construction of environmental accounts.

The panel recommends a concerted federal effort to identify and collect the data needed to measure changes in the quantity and quality of natural-resource and environmental assets and associated nonmarket service flows. Greater emphasis should be placed on measuring effects as directly as possible, particularly on measuring actual human exposures to air and water pollutants. (Recommendations 4.3 and 5.9)

True public goods, such as biodiversity, species preservation, and national parks, present major conceptual difficulties for incorporation into a national accounting system. More work will be needed on techniques for measuring production flows and values for the assets and services of true public goods in order to make them compatible with the prices and quantities used in the core accounts.

Notwithstanding the awesome difficulties that arise in accounting for air quality, this is likely to be the single most significant sector in environmental accounts. Creating accounts for sectors such as clean air is an essential component of efforts to develop a comprehensive set of nonmarket accounts. However, the construction of air-quality accounts transcends the present scope and budget of BEA and will require further research on the underlying physical phenomena, measurement methods, and economics.

BUDGETARY IMPLICATIONS

The cost to BEA and other agencies of developing and maintaining a set of augmented accounts will depend on the intensity and extent of the effort. The costs would be small for a minimal program of incremental improvements limited to a few natural-resource sectors. Estimates provided by BEA indicate that the cost of a small activity, including reinstatement of the pollution abatement survey, would be approximately \$1.5 million annually. Developing a comprehensive set of environmental and augmented accounts would require more funds over a longer period. Although the cost of a comprehensive accounting system will depend on the extent to which BEA is able to draw on data and expertise from other agencies, a preliminary estimate is that a full set of accounts would require incremental outlays for BEA and other agencies of about \$10 million per year for a decade or more.

SUMMARY

In weighing future directions for environmental and augmented accounting in the United States, the panel concludes that developing a comprehensive set of nonmarket accounts is the most promising approach. Because of the high cost and low return involved, reliable nonmarket accounts will not be supplied by the private sector. In a country as large, complex, and wealthy as the United States, providing information on the structure and interactions of the economy and the environment is an essential function of government, and one the federal government is supporting insufficiently at present.

Developing a comprehensive set of nonmarket accounts for the United States is a large undertaking that would stretch the scope and specialized expertise of BEA. Moreover, if undertaken with the currently projected available resources, such a task would clearly result in cutting back other important BEA functions and proposed improvements. The panel is mindful of BEA's important mission and of the invaluable nature of the data it provides on marketed economic

activity. In addition to furnishing key macroeconomic data and information on different sectors of the economy, BEA has been highly innovative in introducing new data and approaches.

The panel concludes that the development of environmental and natural-resource accounts is an essential investment for the nation. It would be even more valuable to develop a comprehensive set of environmental and nonmarket accounts. The panel emphasizes, however, that environmental accounts must not come at the expense of maintaining and improving the current core national accounts, which are a precious national asset. (Recommendation 5.8)

Note

¹ Paragraphs in boldface in this executive summary reflect recommendations in the main report. The numbers after each paragraph refer to the corresponding recommendations in the chapters that follow; for example, Recommendation 5.1 is the first recommendation in Chapter 5.