

16-503E
no.3
c.3

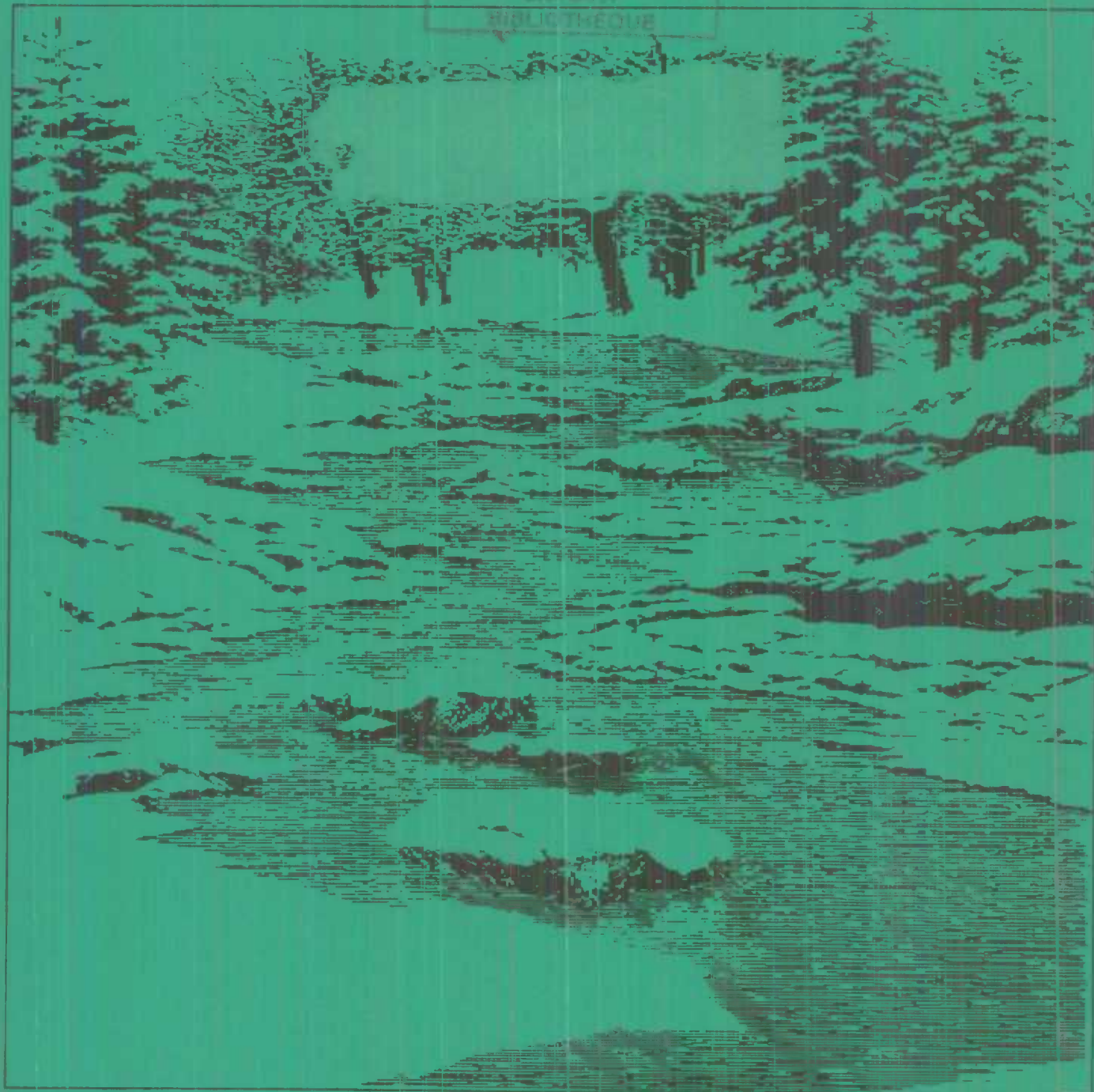
National Accounts
and Environment Division

Division des comptes nationaux
et de l'environnement

An Annotated Bibliography of the Resource and Environmental Accounting and Valuation Literature

Discussion Paper
Number 3

Document de travail
Numéro 3



Statistique Canada
Statistics Canada

Canada

#51719

An Annotated Bibliography of the Resource and Environmental Accounting and Valuation Literature

This article was written by Robert Smith. For further information, please contact him at (613) 951-2810.

Cet article a été écrit par Robert Smith. Pour plus de renseignements, veuillez communiquer avec lui au (613) 951-2810.

This paper is one in a series of internal discussion papers produced in Statistics Canada's National Accounts and Environment Division. These papers address topics related to environmental statistics and the National Accounts components which are currently under development.

Ce document fait partie d'une série de documents internes produits dans la Division des comptes nationaux et de l'environnement de Statistique Canada. Ces documents traitent de sujets reliés aux statistiques de l'environnement et composantes des comptes nationaux au stade de la recherche.

Discussion papers in this series are made available in the official languages in which they were written. Translated versions are not available in most cases.

Les documents de travail de cette série sont disponibles dans la langue officielle dans laquelle ils sont écrits. Les versions traduites ne sont pas disponibles dans la plupart des cas.

An Annotated Bibliography of the Resource and Environmental Accounting and Valuation Literature

by Robert Smith¹

Environment and Natural Resources
Statistics Canada

September 1990

1. Robert Smith wrote this annotated bibliography as a summer student employee. The views expressed in this paper are those of the author and do not necessarily reflect those of Statistics Canada.

Introduction

This bibliography contains annotated citations of the literature dealing, broadly, with the subject of natural resource and environmental accounting and valuation.

The entries are divided into four sections: those dealing with natural resource accounting, those dealing with accounting for the environment, those dealing with resource valuation, and those dealing with the valuation of the environment. It is, of course, impossible to precisely categorise every entry, as many works deal with more than one of these areas. Thus, although an effort has been made to categorise each work based upon its main area of emphasis, there are some entries that could fit equally well into more than one section.

A single asterisk (*) at the beginning of an entry indicates that the item can be found in Environment and Natural Resource's files. A double asterisk (**) indicates that the item can be found in the Statistics Canada library (2nd floor, Coats Building). For those items that cannot be found in either place, a location and call number is provided.

Glossary of Terms

The following are definitions of some of the terms commonly used in the literature.

Defensive expenditures - Expenditures undertaken by any economic agent with the intention of offsetting, remediating or preventing environmental degradation.

Environmental accounting - Any type of measurement, either physical or monetary, of the flows of service from or damage to the natural environment undertaken for the purpose of economic analysis.

Environmental service - Any economically valuable service produced in the natural environment. An example is the pollution absorption service provided by bodies of water.

Hicks' concept of income - ¹ That amount that a person can spend in a week and remain as well off at the end of the week as at the beginning. This concept is often referred to as sustainable income, since it represents the amount a person can spend while keeping the source of income intact indefinitely.

Hotelling's rule - The economic theory, first developed by Harold Hotelling,² that under specific conditions the net profit (rent) on an optimally managed non-renewable resource will grow over time at a rate equal to the rate of interest prevailing in the economy.

Natural capital - Anything produced in the natural environment that is used in any production process.

1. Hicks' J.R. 1946. *Value and Capital*, 2nd Ed. Oxford: Oxford University Press.

2. Hotelling, H. 1931. "The Economics of Exhaustible Resources," in *The Journal of Political Economy*, 39, 2 (April): 137-175.

Resource accounting - Any type of aggregation of resource stocks or flow, either in physical or monetary units, undertaken for the purpose of economic analysis.

User cost - The cost to future generations that results from the use of exhaustible resources or degradation of the environment by the present generation.

Abbreviations

GNP - gross nation product

I-O - input-output

NIPA - United States national income and product account

NNP - net national product

NPV - net present value

SGDP - sustainable gross domestic product of Bartelmus *et al.* (1989)

SNDP - sustainable net domestic product of Bartelmus *et al.* (1989)

SNA - System of National Accounts of the United Nations

UNSO - United Nations Statistical Office

Section I - Natural Resource Accounting

LIST OF REVIEWED PAPERS

- *Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). 1989. *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank.
- *Alfsen, Knut H., Torstein Bye and Lorents Lorentson. 1987. *Natural Resource Accounting and Analysis: The Norwegian Experience 1978 - 1986*. Oslo: Norwegian Central Bureau of Statistics.
- *Bartelmus, Peter, Carsten Stahmer and Jan Van Tongeren. 1989. *SNA Framework for Integrated Environmental and Economic Accounting*. paper presented at the 21st General Conference of the International Association for Research in Income and Wealth, 20-25 August 1989.
- *Bartelmus, Peter. 1990. *Environmentally Sound and Sustainable Development: A Conceptual Framework*. Unpublished.
- *Blades, Derek W.. 1989. *Measuring Pollution Within the Framework of the National Accounts Chapter 5* in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.
- *Daly, Herman E. and John B. Cobb Jr. 1990. "The Index of Sustainable Economic Welfare" an appendix to *For the Common Good: Redirecting the Economy Toward Community, the Environment and a Sustainable Future*. Boston: Beacon Press, 1990.
- **Eisner, Robert. 1989. *The Total Incomes System of Accounts*. Chicago: University of Chicago Press.
- *Ekins, Paul (ed.). 1986. *The Living Economy: A New Economics in the Making*. New York: Routledge and Kegan Paul. **Chapter 6 - Indicators of Economic Progress**.
- *El Serafy, Salah. 1989. *The Proper Calculation of Income from Depletable Natural Resources Chapter 3* in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.
- *Harrison, Anne. 1989. *Introducing Natural Capital into the SNA Chapter 4* in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.
- **Herfindahl, Orris C. and Allen V. Kneese. 1973. "Measuring Social and Economic Change: Benefits and Costs of Environmental Pollution," in Milton Moss (ed). **Studies in Income and Wealth, Volume 38: The Measurement of Social and Economic Performance**. New York: Columbia University Press.
- *Huetting, Rofie. 1988. "Should National Income be Corrected for Environmental Losses? A Theoretical Dilemma, but a Practical Solution." Contribution to **Environmental and Resource Accounting and Their Relevance to the Measurement of Sustainable Development**. Selected papers from Joint UNEP/World Bank Workshops.
- *Huetting, Rofie. 1989a. *Correcting National Income for Environmental Losses: Toward a Practical Solution Chapter 6* in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.
- *Huetting, Rofie and Peter Bosch. 1989b. "Note on Correction of National Income." Netherlands Central Bureau of Statistics

****Juster, F. Thomas. 1973. "A Framework for the Measurement of Economic and Social Performance," in Milton Moss (ed.) Studies in Income and Wealth, Volume 38: The Measurement of Economic and Social Performance. New York: National Bureau of Economic Research.**

***Landefeld, J. Steven and James R. Hines. 1985. "National Accounting for Non-Renewable Natural Resources in the Mining Industries, in The Review of Income and Wealth 31, 1 (March): 1-20.**

***Lone, Oyvind. 1987. *Natural Resource Accounting and Budgeting: A Short History of and Some Critical Reflections on the Norwegian Experience 1975-1987*. Paris: OECD Environment Directorate.**

***Loretsen, Lorents and Knut H. Alfsen. 1989. *Statistics and Analytical Methods for a Sustainable Development*. Oslo: Central Bureau of Statistics of Norway.**

***Norgaard, Richard. 1989. *Linkages Between Environmental and National Income Accounts* Chapter 8 in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.**

***OECD. 1988. *Natural Resource Accounts: Pilot Study Concerning Forest Resources*. ENV/SE/88.20 Paris: OECD Environment Directorate.**

***Opschoor, J.B. 1989. "Towards Sustainable Development: Environmental Change and Macro Indicators". OECD Economics and Statistics Department/Environment Department Joint Seminar on The Economics of Environmental Issues, Paper No. 4. Paris: OECD.**

***Pearce, David W. 1989. *Sustainable Development: Towards an Operational Definition and its Practical Implications*. OECD Economics and Statistics Department/Environment Directorate Joint Seminar on The Economics of Environmental Issues, Paper No. 3. Paris: OECD.**

***Peskin, Henry M. 1976. "A National Accounting Framework for Environmental Assets," in *Journal of Environmental Economics and Management* 2: 255-62.**

***Peskin, Henry M. and Janice Peskin. 1978. "The Valuation of Nonmarket Activities in Income Accounting", in *The Review of Income and Wealth*, 24 (March): 71-91.**

***Peskin, Henry. 1989. *A Proposed Environmental Accounts Framework* Chapter 10 in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.**

***Peskin, Henry. 1990. *A Survey of Resource and Environmental Accounting Practices in Industrialised Countries*. Draft version, Edgvale Associates.**

***Potvin, Joseph R. 1989. "Economic Environmental Accounts: A Conspectus on Current Developments." Report to the Corporate Policy Group of Environment Canada. Ottawa: The Rawson Academy of Aquatic Science.**

***Repetto, Robert, William Magrath, Michael Wells, Christine Beer and Fabrizio Rossini. 1989. *Wasting Assets: Natural Resources in the National Accounts*. Washington: World Resources Institute.**

***Scott, Anthony. 1956. "National Wealth and Natural Wealth", in *The Canadian Journal of Economics and Political Science* 22, 3 (August): 373-78.**

Theys, Jacques. 1989. *Environmental Accounting in Development Policy: The French Experience* Chapter 7 in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for

Sustainable Development. UNEP - World Bank Symposium, Washington: World Bank. 1989.

*Victor, Peter A. 1990a. *"Indicators of Sustainable Development: Some Lessons from Capital Theory"*, Background paper for the Workshop on Indicators of Sustainable Development Economics, Ottawa, 27-28 July, 1990. Canadian Environmental Advisory Council.

*Victor, Peter A. 1990b. *Supplementary Economic Accounts for the Yukon Territory: Report to the Yukon Territorial Government*. Toronto: VHB Research and Consulting Ltd.

*Ward, Michael. 1982. *Accounting for the Depletion of Natural Resources in the National Accounts of Developing Economies*. Paris: OECD Development Centre. Publication No. CD/R(82)3010.

*World Bank. 1989. *"Improved Accounting of Natural Resources and the Environment for More Sustainable Resource Management: A Research Proposal."* World Bank Environment Department Policy and Research Division.

*Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). 1989. *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank.

This document contains eleven papers, of more or less detail, that are the result of several years of meetings and workshops held by the World Bank and the UN Environment Program on the subject of environmental and natural resource accounting. The papers represent the most recent ideas on this subject from some of the world's leading researchers and, as such, contain much information that is relevant to Statistics Canada's project on natural resource accounting. The following chapters are reviewed in this annotated bibliography:

- *Chapter 3 - The Proper Calculation of Income from Depletable Natural Resources, Salah El Serafy.*
- *Chapter 4 - Introducing Natural Capital into the SNA, Anne Harrison.*
- *Chapter 5 - Measuring Pollution Within the Framework of the National Accounts, Derek W. Blades.*
- *Chapter 6 - Correcting National Income for Environmental Losses: Toward a Practical Solution, Roefie Hueting.*
- *Chapter 7 - Environmental Accounting in Development Policy: The French Experience, Jacques Theys.*
- *Chapter 8 - Linkages Between Environmental and National Income Accounts, Richard Norgaard.*
- *Chapter 10 - A Proposed Environmental Accounts Framework, Henry Peskin.*

*Alfsen, Knut H., Torstein Bye and Lorents Lorentson. 1987. *Natural Resource Accounting and Analysis: The Norwegian Experience 1978 - 1986*. Oslo: Norwegian Central Bureau of Statistics.

Description

This publication describes the Norwegian system of natural resource accounting. Chapters 1 and 2 discuss the philosophy that underlies the need for such a system. Chapter 3 provides a nice description of the Norwegian system for the classification of natural resources. Chapter four describes the resource accounts themselves, with several examples of actual accounts used for illustration. The remaining chapters provide a critical review of the Norwegian approach and some suggested areas of priority for further effort.¹

1. This description is purposely brief. A more detailed description of the Norwegian system of resource accounting is included under Louie (1987) in this bibliography.

*Bartelmus, Peter, Carsten Stahmer and Jan Van Tongeren. 1989. *SNA Framework for Integrated Environmental and Economic Accounting*. paper presented at the 21st General Conference of the International Association for Research in Income and Wealth, 20-25 August 1989.

Description

The authors present their proposal for a satellite accounting system for environmental and natural resources. The system is based very closely on the boundaries and concepts contained in the United Nations System of National Accounts. (Bartelmus and Van Tongeren are both members of the UN Statistical Office.) It can be seen as a modification of the input-output framework of national accounting to allow monetary values for the depletion/degradation of environmental assets and expenditures on environmental protection to be calculated.

The framework consist of 2 sets of tables that measure both the stocks and flows of environmental assets within the economy and the natural environment. Table IA is similar to the supply (make) matrix in input-output accounting. It cross-classifies nine economic sectors (including an explicit household sector) with their respective outputs of three types of goods and services: environmental protection services, natural growth products and other goods and service. Within each of these categories, the output of each of the nine sectors is further broken down into the output of environmental protection services and of other goods and services.

Table IB is a use/value added table. The output from table IA is distributed in this table among the nine economic sectors, final demand (which consists of final consumption of government, households and non-profit institutions), exports, and tangible wealth accumulation (which is divided into wealth in the economic sector and wealth in the natural enviroment). The major conceptual deviation from traditional accounts is in the distribution of the output of the economy. The authors treat expenditure on environmental protection by the government and household sectors as intermediate consumption. In traditional accounts this is treated as final consumption. The authors' treatment reflects their opinion that expenditures on environmental protection should not contribute to GNP.

Table IB contains a section for the calculation of "environmental cost", which is composed of the values of quantitative depletion and qualitative degradation of environmental assets, plus the transfer of non-renewable assets from the natural environment to the economy. The subtraction of environmental cost from GNP yields what the authors call sustainable gross domestic product (SGDP). The further subtraction of depreciation of man-made capital from SGDP yields sustainable net domestic product (SNDP).

Table IIA is an opening balance sheet of reproducible or renewable assets (fixed capital goods and stocks) and non-renewable assets (land, soil and sub-soil assets) held by each of the economic sectors used in table IA and B (except for the household sector). Table IIC contains the revaluations of these same assets during the accounting period. Table IID is the closing balance sheet for the accounting period. Table IIB is an expanded version of tangible wealth accumulation (table IB) that breaks wealth accumulation down by each of the economic sectors used in tables IA and B (except for the household sector). The flows of assets recorded in the tangible wealth accumulation table are used to link the supply/use tables with the balance sheet accounts.

Comment

The framework proposed by Bartelmus, Stahmer and Van Tongeren is a very thorough attempt at operationalising the notion of environmental and resource accounting. Unfortunately, there are a number

of conceptual and practical problems that, in my opinion, make the framework of value only as a starting point for further research (it is important to note that the proposed World Bank research project on environmental and natural resource accounting (World Bank, 1989) supports the trial implementation of this framework).

First, there is a practical problem. The proposed framework requires the calculation of monetary values for resource depletion and environmental degradation, but the authors do not duly discuss the problems associated with deriving such values. In fact, it appears that the authors implicitly assume away any valuation problems.

A major conceptual problem with the framework is the authors' definition of sustainable gross domestic product. In standard accounting practice, *gross* is taken to mean "before allowance has been made for the consumption of capital" (see Ahmad, El Serafy and Lutz, 1989; 22). Thus, to deduct a value for natural capital depletion and degradation from GNP to get "sustainable" GNP ignores standard accounting definitions. The proper treatment is to treat the depletion of man-made and natural capital analogously and remove them both to arrive at "sustainable" NDP. To be fair, the authors do note this possibility (p. 14), but only as an alternative to their own treatment, not as the correct and preferred treatment.

A second conceptual weakness is found in their treatment of the expenditures made by the household sector for environmental protection. The framework contains two distinct entries for environmental activities of households: expenditures for environmental protection and expenditures for environmental damage. The former is treated as intermediate consumption and removed from GNP, but the latter is treated as final consumption, thus contributing to GNP. The theoretical distinction between these classes of expenditures is not made clear and it is not clear why they receive different treatment in the use/value added table.

*Bartelmus, Peter. 1990. *Environmentally Sound and Sustainable Development: A Conceptual Framework*. Unpublished.

Description

In this paper Bartelmus "seeks to contribute to the clarification of the meaning of sustainable development by means of a conceptual framework as a first step towards more strategic recommendations" (p. 1). The paper is divided into four sections: "the concept of sustainability", "definitions of sustainable development", "accounting for sustainable development" and "towards a strategic framework".

In section I, Bartelmus develops four concepts of sustainability. These are based on maintaining the supply of natural resource (economic sustainability), maintaining environmental services (environmental sustainability), maintaining human populations (demographic sustainability), and maintaining equitable access to natural resources and environmental services (social sustainability).

In section II, starting from the concepts outlined in section I, he develops three progressively more far-reaching definitions of sustainable development.

Economically sustainable development is defined as:

"development that generates non-declining *per capita* national income by replacing or conserving the sources of the that income, ie. the stocks of produced capital and natural resources."

Environmentally sound and sustainable development adds to the above definition: "...and by allowing for the maintenance of environmental quality as part of an extended economic system." Equitable, environmentally sound and sustainable development goes one step further to include "the equitable distribution of the results of economic activity and of other amenities, including the access to environmental resources and services."

Bartelmus notes that the definition of income from Hicks (roughly, the amount that can be consumed in a period while keeping capital intact) contains the notion of sustainability implicitly. Since natural resources are used as direct inputs into the economic system, he argues, their depletion has a direct effect on income, and allowance for their depletion is thus justified by an appeal to the Hicksian notion of income. He also notes that aggregate monetary indicators (such as GNP) reach a limit when "the valuation of non-monetary effects becomes arbitrary or where social concern overrides individual valuation implicit in market price formation" (p. 13). Thus, he discusses some possibilities for non-monetary analysis of sustainable development using modeling techniques.

In section III he outlines relatively briefly the framework for environmental accounting that he has developed in conjunction with Carsten Stahmer and Jan Van Tongeren (see Bartelmus, Stahmer and Van Tongeren, 1989). He notes that different valuation techniques are required for natural resources depending upon their nature in the economy, that is whether they are substitutable or complimentary. For the former, an estimate of the cost of finding a substitute is said to be the best means of valuation. The latter present more difficulties, but the application of an opportunity cost approach for the calculation of the present-day value of the loss in future use of non-substitutable resources is said to be convincing. Bartelmus mentions Henry Peskin's idea of introducing a "nature" sector account into national accounting (see chapter 10 of Ahmad, El Serafy and Lutz, 1989 and Peskin, 1976), but he considers the problems of valuing nature's production services to be almost insurmountable. He notes that Bartelmus *et al.* (1989) avoid this problem by confining their framework to the standard boundaries of national accounting. He is critical of those who advocate removing "defensive environmental expenditures" from GNP without considering the implications for national accounting. Bartelmus *et al.* (1989) allow for the deduction of defensive

expenditures in their framework, but treat fixed capital formation for environmental protection as final demand, consistent with standard accounting principles.

Finally, section IV discusses means of operationalising the concepts outlined in discussion at the local, national and international level.

Comment

Bartelmus' paper is important for two reasons. First, it shows that sustainable development will not be achieved merely by linking our current economic system with the environment. There are considerations, equity for instance, that go beyond the boundaries of economic analysis. Outside of these boundaries recourse to other types of analysis must be sought. Second, the paper emphasises the role that the inclusion of natural resources and the environment in the national accounts has to play in the economic analysis of sustainable development.

*Blades, Derek W.. 1989. *Measuring Pollution Within the Framework of the National Accounts* Chapter 5 in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.

Description

Blades' paper deals with the usefulness of the current framework of national accounts as a means of measuring four separate aspects of pollution: the output of pollutants, damage caused by pollution, the costs of pollution abatement, and the benefits of pollution abatement.

Blades discusses three possible applications of conventional input-output tables to the measurement of pollution. He briefly discusses the possibility of using I-O tables to measure the **output of pollutants**, but concludes that such an analysis is too difficult; the data requirements are prohibitive. I-O tables may also be used to make explicit the data contained in the national accounts that pertains to the **costs of pollution**. Blades concedes that this would be difficult, but maintains that some of the major costs could be determined in this manner. Finally, I-O tables could be used, according to Blades, to determine the **costs of pollution abatement** borne by governments, industries and households. Data on pollution abatement expenditures by government is, in principle, available from the United Nation's "Classification of the Functions of Government". Expenditure by the industrial and household sectors are not so readily available, and there are conceptual problems involved in their collection. Blades provides examples of what the input-output tables would look like for the measurement of pollution damage and abatement costs.

With respect to measuring the **benefits of pollution abatement**, Blades lists three potential methods. The first is to value the benefit of pollution abatement at the value of the damage avoided. This, as Blades points out, runs counter to the fact that goods and services are not usually valued at the cost of the damage they prevent. Next he considers valuing the benefits of pollution abatement at the cost of the providing the abatement program. He notes that this is a common means by which national accountants value goods and services for which there is no market price. This approach assumes that people value such programs at their cost, which is not necessarily a reasonable assumption. A final approach is to attempt to determine a demand curve for pollution abatement and use this in combination a supply curve to simulate a market price for abatement. There are many problems inherent in measuring such demand curves, however, and Blades does not have much faith that they can be constructed. Thus, he concludes that valuing the benefits of pollution abatement at the cost of its provision is all that can be expected in the near future.

Blades sums up by saying that the national accounts are not useful for measuring the output of pollutants, they are not likely to be useful for measuring the benefits of pollution abatement (at least on a "market basis"), they have good potential for measuring the some of the damages due to pollution, and they can and have been used to measure the costs of pollution abatement.

Comment

While Blades' paper is not particularly illuminating with regard to techniques for measuring and evaluating certain aspects of pollution, it does serve to point out that the current SNA is mainly inadequate for such an endeavour. Thus, any effort at environmental accounting will most likely require the development of supplementary systems of accounting. Any effort based on extracting information from the current SNA will, according to Blades' analysis, be of only limited effectiveness.

*Daly, Herman E. and John B. Cobb Jr. 1990. *"The Index of Sustainable Economic Welfare"* an appendix to *For the Common Good: Redirecting the Economy Toward Community, the Environment and a Sustainable Future*. Boston: Beacon Press, 1990.

Description

One of the themes of Daly and Cobb's work is the need for an alternative to GNP as a measure of economic welfare. Building on the earlier works of Nordhaus and Tobin² and others the authors develop their own welfare measure, which they call the index of sustainable economic welfare (ISEW).

Like GNP, their index uses individual consumption as the basis for economic welfare (a basis that the authors admit relies on the tenuous assumption that people are better off when they consume more). However, in contrast to GNP, Daly and Cobb take explicit account of income distribution in calculating the contribution of consumption to welfare. Thus, in the ISEW, greater weight is given to consumption by relatively poorer segments of the population.

Using income distribution adjusted consumption as a basis, Daly and Cobb add and subtract values for a number of benefits and costs that they believe contribute to and detract from economic welfare. Their method for making two such adjustments is outlined below.

With respect to valuing the cost of the depletion of natural resources, Daly and Cobb's analysis is somewhat confusing. They begin by stating their support for El Serafy's user cost approach (see chapter 3 of Ahmad, El Serafy and Lutz, 1989). Then they go on to make some valid criticisms of his approach. However, they do not explicitly criticise El Serafy for his practice of discounting the future. This is rather odd, since earlier in their analysis Daly and Cobb state their opposition to the practice of discounting, on the basis that what is appropriate for a rational individual is not necessarily appropriate for society as a whole. Since the use of a discount rate is necessary for El Serafy's method to be non-trivial (at a zero discount rate the solution to his equation is the same no matter what the other parameters are), Daly and Cobb's support of his method in principle is contrary to their rejection of discounting. In the end, they recommend deducting 100 percent of the value of mineral production from national income. They admit that they did not arrive at this figure "through any precise means" (p. 439) and that they are not happy with this arbitrary approach.

Daly and Cobb make a deduction for the value of long-term environmental damage. This they assume to be in direct proportion to the consumption of nonrenewable (fossil and nuclear) energy. The undiscounted value of damage done by the consumption of nonrenewable fuel resources they put at US\$0.50 (1972) per barrel equivalent. Thus, by determining the total consumption of nonrenewable energy each year, they come up with a value of the long term environmental damage caused during that year.

Daly and Cobb produce a time series (1950-86) of ISEW and per capita ISEW for the United States. The series indicates that both ISEW and PC-ISEW grew more or less steadily from 1950 until leveling off in the 1970's and then began to decline in the 1980's. The decline in recent years is attributed to the increasing inequality of income distribution during the Reagan administration, as well as rising real energy prices and the decline in the international position of the U.S. economy.

Comment

2. Nordhaus, William and James Tobin. 1972. *Is Growth Obsolete?* in Milton Moss (ed.) *Studies in Income and Wealth, Volume 38: The Measurement of Economic and Social Performance*. New York and London: Columbia University Press.

The ISEW derived by Daly and Cobb is, I believe, an interesting step toward creating a more meaningful measure of welfare than GNP. If it does nothing else, it shows the conceptual and practical difficulties that one runs up against in attempting to define boundaries and collect the data necessary to construct such an index.

Unfortunately, the adjustments that the authors choose to include in their ISEW are so full of subjective guesswork as to be of no real practical value. For instance, on what do they base their estimate of the long-term environmental cost? The answer is, nothing. It simply represents what they think is reasonable. Even conceptually this estimate is flawed, for it implies that if no non-renewable fuel was consumed then no long-term environmental damage would occur. One has only to imagine the consequences of relying entirely on renewable wood energy to fuel the economy to see the error in their thinking.

Another criticism of the ISEW is that, since it is an aggregate measure, it can say little about the distribution of economic welfare. The authors did attempt to correct for this flaw by weighting consumption in favour of those with less income. However, no attempt was made to weight the other contributions to welfare in the same manner. Thus, the ISEW really says little about how individual groups within society fair with respect to economic welfare.

In defence of Daly and Cobb, they admit that their index contains many subjective elements, assumptions and gaps. They also admit that the assumptions made in deriving the values for the cost of resource depletion and long-term environmental damage are weak enough to warrant calculating the ISEW without these values. The trends in ISEW do not change when these values are removed. One has the feeling that Daly and Cobb were more concerned with showing that the calculation of an index like the ISEW is possible than with providing a rigorous estimate.

Eisner, Robert. 1989. *The Total Incomes System of Accounts*. Chicago: University of Chicago Press.

Description

The Total Incomes System of Accounts is a very detailed book that presents Eisner's concept of an extended system of national accounts. His system is based on the notion that all sources of income in the economy, whether market or non-market, should be included in the national accounts.

Eisner does not see fit, however, to include any allowance for the depletion of natural resources in his version of the capital consumption allowance. Nor does he attempt to include any value for consumption of environmental services. His main reason for excluding natural resources and the environment from his accounts seems to be that "proper and consistent handling of natural resources and the environment is difficult" (p. 86). Although he chooses not to make allowance for natural resources and the environment, some of Eisner's analysis is applicable to these factors nonetheless.

He spends some time discussing the appropriate boundary between intermediate and final product and the implications of this boundary for the national accounts. His definition of final product is "those goods and services that are the penultimate ingredients of human well-being" (p. 8). He uses this definition to argue that much of government expenditure now counted as final consumption is, in fact, intermediate in nature. Police services and national defence, for example, are in this category. It is easy to extend this argument to include government expenditure to clean up the environment. These expenditures represent costs of maintaining the environment in a state where people are able to "consume" its services and thereby derive well-being. Thus, such expenditures do not represent "penultimate ingredients of well-being" and should not be considered final product.

Another of Eisner's arguments is that the concept of investment should be extended to include, among other things, additions to inventories in all sectors of the economy. He notes that changes in inventories of natural resources "might" be included in this extension.

Eisner also recommends including net revaluations in income. Net revaluations are the "changes in capital values net of those changes necessary to keep real value intact" (p. 17). He justifies the inclusion of net revaluations in income by appealing to Hicks' notion of income as that amount that can be consumed while keeping real wealth intact. This treatment could have significant implications for the income derived from natural resources. For instance, it implies that capital gains to resource owners resulting from price changes or technological innovation should be included in income. As is clear from Repetto *et al.*'s case study of Indonesia (see Repetto *et al.*, 1989) doing so can result in large fluctuations in national income. Eisner admits that net revaluations do show more fluctuation from year to year than other forms of current income. He suggests separating net revaluations from other sorts of income for some kinds of analysis to deal with this problem.

Comment

Eisner's extended system of national accounts is far too extensive and complex for a cursory analysis. However, some comments (besides the ones above) are possible.

Many authors have stated their position that "defensive expenditures" should be considered intermediate costs instead of final product. Eisner takes this argument beyond the mere statement that defensive expenditures are a cost to society and proves *why* they are a cost to society. This alone is a significant contribution.

It is unfortunate that he chose not to include natural resources and the environment in his system. His argument that there are difficulties in doing so does not hold much water, since there are difficulties of no less degree involved in the extensions he does make. Furthermore, the inclusion of natural resources is demanded by logic and the desire for comprehensiveness in a "total incomes" system of accounts.

*Ekins, Paul (ed.). 1986. *The Living Economy: A New Economics in the Making*. New York: Routledge and Kegan Paul. **Chapter 6 - Indicators of Economic Progress.**

Description

The Living Economy is a collection of the papers presented at "The Other Economic Summits" held during the mid 1980's. The purpose of these summits was to provide a forum for the discussion of alternatives to growth-oriented economics. The general perspective of the contributors to this book is that economic goals should be tied closely to social and environmental goals and that economic efficiency should not hold sway at the expense of these goals.

Chapter 6 presents five alternative concepts for measures of economic and social progress that are meant to be more meaningful than the narrowly defined gross national product. Ekins stresses that, to the extent possible, the data collection for these measures should be carried out and reported at the local level. This would enable communities to better grasp the needs and opportunities they are faced with, and the resources available for them to meet their needs and opportunities.

The need for natural resource indicators is identified as one of these alternative concepts. Natural resources include energy sources, mineral deposits, soil, plant and tree resources, and water. Degradation and depletion of these would be tracked by specific resource indicators. Ekins recommends physical accounting for each resource class, rather than the development of a gross monetary aggregate. This is in recognition of the fact that, for self-reliance, each resource is important in its own right.

Another of the alternative concepts, (this one developed by Christian Leipert) is that of an adjusted national product. Leipert's opinion is that expenditures made for the protection and rehabilitation of the environment (defensive expenditures) should be removed from GNP to arrive at an adjusted national product. These expenditures, he argues, do not contribute to consumption opportunities, but instead represent costs associated with modern society. Leipert lists five categories of defensive expenditures:

- external costs of the general growth process of production and consumption (or of production stagnating at a high level);
- external costs of spatial concentration, centralisation of production and associated urbanisation;
- increasing risk-susceptibility of the industrial system;
- costs of car transport; and
- costs arising from unhealthy consumption and behavioural patterns as well as living and working conditions.

The other three alternative measurement concepts are: health indicators, social objective indicators, and indicators of the informal economy. Ekins feels that the implementation of the above set of measures is possible to a limited extent with existing data sources. Improvement over the whole range would be a real indication of progress in terms of health, wealth, economic welfare and the fulfillment of obligations to future generations.

Comment

For those who believe that growth-oriented economics is at least partly to blame for the deteriorating state of the environment, *The Living Economy* is an important book. It is important not only because it makes a persuasive argument that change is needed, but because it gives many examples of how change can be

effected. Many of these examples are based on actual experiences of the contributors with alternative economic adjendas.

With respect to resource accounting, the book is relatively brief and mainly descriptive. Thus, it serves mostly to draw attention to the need for some measure of the depletion and degradation of natural resources. Ekins' argument against aggregated, monetised indicators in favour of disaggregated, physical indicators is worth keeping in mind. It implicitly recognises that many natural resources should be considered as complimentary rather than substitutable in economic analysis. However, to argue that there is *no* place for economic valuation of natural resources is to take the argument too far. There is much to be said in favour of a pluralistic approach that uses both physical and monetary indicators.

Leipert's argument for deducting defensive expenditures from GNP is weakened by the fact that he does not give an economic argument for *why* this should be done. Eisner (1989) provides this argument. Defensive expenditures should not be included in GNP because they do not provide a penultimate contribution to human welfare. That is, the "consumption" of defensive expenditures does not contribute directly to welfare. Nonetheless, Leipert's contribution is important in that he provides a useful classification of defensive expenditures.

However, some of the expenditures that are listed as defensive are questionable from a conceptual point of view. For instance, I am not convinced that the costs arising from unhealthy consumption and behaviour patterns (such as smoking) should be considered defensive expenditures. Clearly, the treatment of addictions and other bad habits contributes, perhaps not positively but certainly directly, to welfare and should be considered as final consumption.

*El Serafy, Salah. 1989. *The Proper Calculation of Income from Depletable Natural Resources* Chapter 3 in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.

Description

As the title suggests, El Serafy's paper deals only with the calculation of income from depletable natural resources (eg. oil, minerals). Renewable natural resources are given only a cursory treatment.¹

El Serafy feels that it is important to make corrections for the depletion of resources directly to the GNP, rather than subtracting a value representing the depletion of resources from the GNP to arrive at a corrected NNP. He justifies this approach in two ways. First, he claims that a downward adjustment must be made to the GNP to reflect resource depletion because not to do so is to confuse current production with capital consumption. Second, he claims that any income adjustment made should be made to GNP because the inherent arbitrariness involved in the estimation of NNP limits the usefulness of that measure.

According to El Serafy it is not reasonable to deduct the full value of mineral extraction from national income. In his opinion, this denies the fact that countries endowed with natural resources "are evidently better off than those without such resources, and they can enjoy a higher standard of living than the latter by virtue of their resource endowment" (p. 13). Instead, the proper approach is to estimate that portion of the receipts from mineral extraction that represents capital depletion (El Serafy calls this a user cost) and exclude this entirely from the GNP. The remainder of the receipts can be considered current income and included in GNP. The value of the user cost is just that amount that must be invested in some alternative activity at a given rate of discount that will generate a steady income flow equal to that earned from the mine. This income flow should commence in the period following the end of production in the mine. He has developed the following formula for calculating these values:

$$\frac{X}{R} = 1 - \frac{1}{(1+r)^{n+1}};$$

where X is the amount that can be treated as current income, R is total receipts less extraction costs, r is the rate of discount and n is the number of years remaining until full depletion of the resource at current extraction rates. The user cost is equal to R - X. El Serafy's paper contains values of X/R for given values of r and n in both graphical and tabular form.

There are several aspects of El Serafy's method that should be made clear. First, there is the need to choose a discount rate. El Serafy recommends a rate of 5 percent, which could be periodically adjusted to reflect changes in long-term market rates. Second, the setting aside of a portion of receipts for reinvestment is only a metaphor, and is not intended as anything more than a guide to prudent behaviour. Third, changes in the rate of extraction and the discovery or new or revaluation of current reserves are dealt with through a change in the value of n in the equation above. Changes in the value of the resource due to changes in the market or technology cannot be addressed by this method since market price is taken as a given in the formula.

1. According to El Serafy, the cost of managing renewable resources for a sustained yield should be deducted from the receipts from their sale to arrive at true net value added. In the case of renewable resources that are not managed for a sustained yield, those who calculate national income should impute a value for proper management (a capital consumption charge), based on technologically acceptable criteria, and subtract this from current receipts to determine true income from these activities.

It is worth noting, in light of Statistics Canada's intention of focusing on accounting for natural resources in the nation's wealth accounts, that El Serafy does not favour such accounting. In his opinion, the calculation of "the absolute values of total resources and their annual changes...would be as arbitrary as they would be unedifying" (Ahmad *et al.*, 17).

Comment

There are several problems with El Serafy's method. The major fault is his mistaken interpretation of the notion of *gross* national product, which, as Anne Harrison (see chapter 4) has pointed out, is intended as a measure of national productivity before allowances have been made for the depletion of capital. El Serafy's proposal to deduct from GNP the capital consumption (user cost) portion of the receipts from the sale of depletable resources flies in the face of this definition.

El Serafy does not, in my opinion, deal adequately with the issue of determining an appropriate discount rate. His proposed value of 5 percent, which is based on "what the classical economists used to call a natural rate of time preference" (Ahmad *et al.*, 16), is, to say the least, weakly argued. His treatment of the issue of discounting the future is even more disconcerting when one realises that the choice of rate has a very significant effect on the above formula. As the chosen rate of discount increases the amount of the receipts that must be considered capital consumption decreases exponentially.

El Serafy's analysis ignores both inflation and population growth, both of which will tend to reduce the per capita welfare provided by a constant income stretching into the future. If the objective of economic policy is to keep per capita welfare intact (rather than per capita income) then El Serafy's method requires that investments be found that will provide a rate of return that grows at a rate equal to the rate of growth of inflation and population combined in order to maintain per capita welfare. Investment opportunities such as these are not easy to come by.

Finally, El Serafy makes implicit assumptions about the sustainability of future economic activity that may not be appropriate in today's world. That is, he assumes that economic investment opportunities that will provide a non-diminishing return *ad infinitum* exist, even though much of the resource and environmental base that economic activity has been traditionally reliant upon is rapidly being depleted and degraded.

*Harrison, Anne. 1989. *Introducing Natural Capital into the SNA* Chapter 4 in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.

Description

Harrison's paper deals with means of including in the national accounts values for the depletion of natural resources and for expenditures on prevention and amelioration of environmental degradation. She divides natural resources into two categories: exploitable resources (what are normally considered renewable and nonrenewable resources) and permanent resources (air, land and water).

Harrison believes that exploitable resources should be treated as natural capital. Part of what is now treated as gross operating surplus from their sale should be considered capital consumption and net operating surplus should be decreased by this amount. A matching entry should appear in a balance sheet of natural capital assets. She makes no effort to explain why she considers only part of the surplus to be capital consumption, or to indicate how this portion is to be determined.

With respect to permanent resources, Harrison identifies two categories of expenditure: expenditures made in order to prevent the degradation of these natural assets, and expenditures made in order to ameliorate damage that has already occurred. Preventive expenditures, according to Harrison, should be included in the GNP (she is very unclear and ambiguous on this point). Environmental enhancement programs (amelioration expenditures) should be considered capital formation and not current consumption.

Harrison mentions the possibility of valuing permanent resources through the monitoring of resource quality indices. The value of these resources could be estimated as the cost of making improvements to their quality.

The most interesting aspect of Harrison's paper is her discussion of "sustainability factors", which she defines as the ratio of the opening and closing stocks of resources (adjusted for price change) in the national balance sheets during a given accounting period. These factors could serve as useful guides for determining the sustainability of income. She cites several other benefits of such factors: they can be applied at detailed as well as aggregate levels, they are independent of price effects, and they can be applied to reproducible and human capital (as in the ratio of trained professionals at the beginning and end of the period) as well.

Comment

Harrison's paper suffers from one serious flaw. This is her ambiguity with respect to the use of the term "natural resources". She defines a potentially useful taxonomy early in the paper that she all but ignores throughout the remainder. This results in confusion on the part of the reader (this reader, at least) and a distinct lack of coherence in her arguments. As a result, it is quite difficult to evaluate their rigour.

One potential area of concern lies in her argument that the depletion of natural resources (I believe that she means permanent resources, but this is not clear) should be treated as capital consumption and a value for this consumption explicitly included in GNP. This would lead to double counting, since the depletion of these resources is already implicitly included in the GNP as part of the value added to the products that are manufactured using environmental factor inputs. There are other areas of her paper that are not sound, I believe, but her ambiguity makes them difficult to refute.

****Herfindahl, Orris C. and Allen V. Kneese. 1973. "Measuring Social and Economic Change: Benefits and Costs of Environmental Pollution," in Milton Moss (ed). *Studies in Income and Wealth, Volume 38: The Measurement of Social and Economic Performance*. New York: Columbia University Press.**

Description

Herfindahl and Kneese's article deals with, as the title indicates, means for measuring the benefits and costs of pollution. The article confines itself to general observations about how cost and benefit estimates may be made and what data is required. No attempts at estimation are made. The authors discuss the measurement of the benefits and costs of pollution in two ways. One, within a national accounting framework and, two, through the use of models (modified input-output, materials balance and activity analysis). Only the former will be described below.

The authors begin their discussion of modifications to national accounting practices by asserting that official definitions should not be changed. This is both because of the desirability of maintaining consistency in time series and because the advantages of changed definitions are not yet clear. Thus, they recommend accounting for the benefits and costs of pollution in the form of auxiliary series to the main accounts.

According to Herfindahl and Kneese, there are two categories of expenditures that should be deducted from national income: defensive expenditures by governments and households and expenditures for pollution control by government and households. Their justification for this treatment is twofold. One, these expenditures "can be viewed simply as being necessary to maintain, at some specified level, the service flow naturally provided by the [environmental] assets" (p. 452). Two, consistency demands treating government and household pollution control expenditures as intermediate costs since this is already the case for the business sector. They note that the expenditures in these categories made by households are likely small enough to be ignored, except for the case of emission control devices on automobiles. Auxiliary series of these expenditures could be kept and used to produce a modified NNP net of the costs of pollution control and defensive expenditures.

The authors state explicitly that their modifications do not come close to indicating the "true" welfare changes that result from changes in the flows of environmental services. Such an indicator requires the valuation of the services themselves and capital accounting for increases and decreases in the value of natural assets.

Comment

I agree with Herfindahl and Kneese that pollution control costs and defensive expenditures ought to be seen as a cost of maintaining the flow of environmental services. However, I find their discussion of the proper treatment of these expenditures to be confusing. On one hand, they suggest that expenditures made by governments and households should be treated analogously to similar expenditures made by business. That is, they should be treated as intermediate consumption and, therefore, not included in GNP. Yet, in the next breath they recommend deducting government and household pollution control and defensive expenditures from NNP. The authors appear hopelessly confused in their notions of gross and net product and how intermediate consumption relates to each of these. Thus, while the paper does contain some good ideas, its greatest value is as an example of the confusion that results from vague and non-consistent use of economic concepts.

*Hueting, Rofie. 1988. *"Should National Income be Corrected for Environmental Losses? A Theoretical Dilemma, but a Practical Solution."* Contribution to **Environmental and Resource Accounting and Their Relevance to the Measurement of Sustainable Development**. Selected papers from Joint UNEP/World Bank Workshops.

This paper is essentially the same as that by Hueting in chapter 6 of Ahmad, El Serafy and Lutz, 1989, with one difference: he presents an example of the framework of data requirements for calculating the expenditure necessary to reduce soil erosion in Indonesia to its natural level. This is an example of the sort of analysis required to determine the costs to a nation of achieving sustainable development.

*Hueting, Roefie. 1989a. *Correcting National Income for Environmental Losses: Toward a Practical Solution* Chapter 6 in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.

Description

Hueting's argument is that much of what is now included as product in the GNP is actually a cost to society. This portion, he argues, must be deducted from GNP. He notes that Kuznets identified three classes of such expenditures over 40 years ago: expenditure invoked by the urban pattern of living, expenditure inherent in participation in the technically and monetarily complex civilisation of industrial countries, and the major part of government activity. To this list Hueting adds his own: the expenditure on measures that compensate for, redress, or guard against losses of environmental functions. Hueting feels that correcting GNP for this final category is quite possible. The major part of the remainder of his paper is spent discussing the possibility of complementing the correction of GNP with a measure of the cost of achieving sustainable economic development.

Hueting feels that standards for the availability of environmental functions can be set on the basis of health and sustainable economic development. Once these standards are set, then the costs of achieving them could be calculated. This cost would represent the "distance" that society has drifted from sustainable development and would be a useful measure for complementing corrected GNP statistics.

As proof that the calculation of such costs is feasible, Hueting presents the results of an economic study of the Netherlands economy. The study modelled the Netherlands' economy to the year 2000 based on current growth trends and on a scenario that gave priority to environmental protection and sustainable development. Reasonable estimates of the costs of achieving the second scenario were developed by Dutch scientific institutes. Hueting notes that such a study has drawbacks: it does not represent individual valuations, no measures can be formulated for irreversible losses and it is very time consuming. As for advantages, such a study compels an exact definition of sustainable development and avoids the necessity of determining individual willingness to pay for environmental functions (which Hueting believes is not feasible). As for the data requirements, he claims that they are necessary in any case if a policy on the environment is to be formulated.

Comment

Many of the suggestions that Hueting makes are interesting. The question that must be asked, however, is how operational they can be made. In this sense, his discussion of the practical aspects of making corrections to the GNP is inadequate. I suspect that this may be more because of space limitations in this particular paper than because of any bias toward theory and away from practice on the part of the author. I say this because Hueting has been affiliated with the Netherlands Central Bureau of Statistics for many years and I expect, therefore, that he has kept practicalities in mind while formulating his arguments. The major stumbling block to Hueting's approach might be arguments about the objectives of sustainable development. Without consensus in this area his ideas cannot be made operational.

Hueting's notion of an aggregate indicator of the distance from a sustainable economy is unlikely to be of much value as a policy tool. Of more use would be an indicator for individual sectors of the economy. With a set of sector indicators policy makers could fine tune their programs to deal with sources of non-sustainability directly. An aggregate indicator would make it difficult or impossible to pick out these individual sources and, therefore, difficult to formulate effective policy.

*Hueting, Roefie and Peter Bosch. 1989b. *"Note on Correction of National Income."*
Netherlands Central Bureau of Statistics

This paper is a short elaboration on Hueting's theme (see Hueting 1989a) of correcting national income for environmental losses on the basis of meeting standards for sustainable economic development. This paper presents a list of thirteen steps that are involved in calculating the correction to national income based on standards for sustainable development. In other respects it does not include any new insights not contained in Hueting's paper cited above.

****Juster, F. Thomas. 1973. "A Framework for the Measurement of Economic and Social Performance," in Milton Moss (ed.) *Studies in Income and Wealth, Volume 38: The Measurement of Economic and Social Performance*. New York: National Bureau of Economic Research.**

Description

In his paper, Juster argues for significant extensions of national accounting techniques. He does so both because he wishes to improve the usefulness of the accounts as measures of welfare, and because he feels that the accounts are, in a number of ways, theoretically weak from an economic perspective. The basic principle from which Juster starts his discussion is that income is derived from wealth. He does not suggest that, due to this, it is possible or necessary to construct wealth accounts, but rather that a wealth framework is necessary for the proper interpretation of various types of economic activity. The wealth framework that must be implicit in any system of national accounts, according to Juster, includes:

- reproducible tangible wealth (structures and durable equipment);
- reproducible intangible wealth (the stock of disembodied socially useful knowledge);
- human wealth (the stock of skills and knowledge embodied in persons);
- natural physical resource wealth (the stock of mineral, forest, water, climate, etc.); and
- sociopolitical wealth (the stock of personal and national security, freedom, equity, privacy, etc.).

Although Juster deals with the conceptual issues involved in accounting for each of these categories in some detail, only his discussion of natural resource wealth is summarised here.

It is Juster's opinion that current national accounting techniques in the U.S. deal adequately with impact of changes in stocks of physical environmental resources on the operations of the business sector. Both the costs of environmental degradation and the benefits of the use of "free" environmental goods are captured in prices, profits and investment made by businesses. Where the gap exists is in regard to the effect of changes in resource stocks on the flow of consumption benefits to final consumers. He does not make an effort to outline how these costs may be measured, but merely states that he believes that they can be approximated by estimates that are more difficult to make but no more arbitrary than others now included in the accounts.

With respect to the proper accounting for defensive expenditures undertaken to offset or prevent environmental damage, Juster assumes that these do not contribute to an improvement in the state of the environment, but merely reduce the rate of environmental degradation relative to that which would occur if no defensive expenditure were made at all. Thus, these outlays do not increase welfare in any way and should not be included in net income. Juster notes that business expenditure for environmental protection is now counted as intermediate and thus is properly handled, but that defensive outlays by households and governments are improperly treated as final product.

Comment

There are many possible comments that can be made with respect to Juster's paper. Of these, the most important is that the paper is definitely worth a thorough reading. It, along with the comments supplied by George Jaszi, Robert Eisner, Robert Solow and a final reply by Juster, is an excellent and informative discussion of most, if not all, of the issues that are important to any concept of an extended set of national accounts. The comments by Jaszi, in particular, point to the differences in mind and method that exist

between experts in this field.

*Landefeld, J. Steven and James R. Hines. 1985. "National Accounting for Non-Renewable Natural Resources in the Mining Industries, in *The Review of Income and Wealth* 31, 1 (March): 1-20.

Description

This paper discusses some of the shortcomings of the U.S. national income and product accounts (NIPA's) in dealing with the discovery and depletion of natural resources (specifically minerals and oil and gas). The authors' view is that discovery of these resources should be treated as a contribution to gross private domestic investment and depletion as depreciation of this investment. The value of the investment is equal to the discovery value of the resource. According to Landefeld and Hines, the uncertainties associated with valuing discoveries and stocks of natural resources² are significant enough that the inclusion of discovery and depletion of natural resources directly in the NIPA's is not justified. Rather, the information should be used as a supplement to the information in the NIPA's.

They propose using simple T-accounts to account for the discovery value and depletion of natural resources. As noted, under their system, the discovery of natural resources results in an increase in gross private domestic investment (and, therefore, a corresponding increase in GNP) equal to the value of the discovery. Since resource discovery is now treated as investment, there must be a corresponding depletion of the investment. This is calculated as straight-line depreciation and added to the producing firm's capital consumption allowance. This results in a constant GNP but a drop in NNP equal to the increase in the CCA.

Comment

Landefeld and Hines' proposal to treat discovery and depletion of resources analogously to investment and depreciation raises some questions. First of all, is it conceptually correct to treat the discovery of resources as investment? In economics investment is normally taken to mean expenditure on new productive capital. Thus, it is possible to view the expenditure on drilling equipment to search for oil as investment, but it makes less sense to consider the oil discovered as investment. Rather, discovery of should be seen not as an investment, but as a change in assets. Second, if one is to consider the discovery of resources as investment, what is the appropriate value to place on the investment? Is it the cost of acquisition? Is it the value of the discovery at price times quantity? Is it the present value of the future expected income from the discovery? The authors skirt this decision by assuming that valuation problems have been solved. Third, what, if any, is the relationship between an accounting rate of depreciation and the rate of physical depletion of oil from a well. In fact, there is very likely no such relationship at all. Thus, Landefeld and Hines' proposal serves to increase the distance of the national accounts from reality rather than to improve the accounts as indicators of actual economic activity.

2. For a description of Landefeld and Hines' analysis of the valuation of natural resources, see the corresponding entry in section III of this bibliography.

*Lone, Oyvind. 1987. *Natural Resource Accounting and Budgeting: A Short History of and Some Critical Reflections on the Norwegian Experience 1975-1987*. Paris: OECD Environment Directorate.

Description

Lone's paper presents an informative view of the development of the Norwegian system of natural resource accounting³ from its inception until 1987.

The early emphasis of the Norwegian system was on energy and fisheries, and illustrative accounts were regularly produced soon after 1978. It was not until 1985 that the first practical resource account was produced in Norway. The conceptual framework from which the Norwegian accounting system was developed saw the role of resource accounting as a way to

- provide an integrated information system for the whole resource process;
- measure resources in physical units and thus be able to provide material and/or energy balances and flows; and
- connect these accounts to economic aggregates, above all to national accounts and economic statistics and econometric and forecasting models.

The Norwegian system divides resources into two categories: material and environmental resources. Material resources are those that provide society with goods that are traded on the market and are mainly substitutable. Environmental resources are those that provide society with services, are not usually traded and are not substitutable. The material resource category is subdivided into mineral (non-renewable) resources, biotic (living, conditionally renewable) resources and inflowing (permanent) resources. The last category consists of solar radiation, ocean currents and the hydrological cycle. Environmental resources consist of those services provided by the air, water and land. The classification of resources into the above categories is a result of the differences in the use and importance of different resources, and the different structure and data requirements for accounts of material and environmental resources.

The emphasis of the Norwegian system is on accounting for natural resources in terms of physical units. This is so because they wanted to avoid complicated indexing with monetary units and to reflect the reality of resources as physical goods. The provision of a link with ecological analysis was also a consideration in deciding on physical accounting. Further, physical accounting made it possible to use a material balance approach to resource accounting. According to Lone, this approach facilitates linkages of the resource accounts with the economic accounts.

For a variety of reasons (many of which are political in nature), the Norwegian system of resource accounting has not been very successful. Only the energy accounts (which are frequently used by several governmental ministries for forecasting and policy development) have become widely accepted. The accounts for fisheries, forests and minerals can only be considered failures. In light of the Norwegian experience, Lone makes the following recommendations to any nation that is considering implementing its own system of natural resource accounting:

3. For a description of the Norwegian resource accounting system that provides more graphic examples of actual accounts see Alfsson, Bye and Lorentsen, 1987.

- identify important resource and environmental problems and the major decision-making institutions that will use the accounts;
- concentrate on a few of the most important of these problems where it is possible to achieve results in a relatively short time period, and where managers are willing and able to use resource accounts;
- involve managers/users and political institutions as early and as closely as possible in the development of the accounts;
- develop the necessary integrated economic/ecological expertise in and around the central institutions responsible for resource accounting to ensure the continuity of the human resources required for the undertaking;
- exploit to the utmost existing data collection routines, management concepts and tools capable of being integrated with and used as part of the accounting system; and
- avoid ambitious theoretical system building and resist the temptation to engage in large, indiscriminate data collection that very easily may emerge as an end in itself.

*Lorentsen, Lorents and Knut H. Alfsen. 1989. *Statistics and Analytical Methods for a Sustainable Development*. Oslo: Central Bureau of Statistics of Norway.

Description

Lorentsen and Alfsen use the Brundtland Commission report⁴ as a backdrop for their discussion of the statistical and analytical requirements for achieving sustainable development. According to the authors, for an economist or a statistician sustainable development is development that maintains or increases the level of national wealth. This is so because wealth represents the possibility for future consumption. Wealth is a combination of human, natural and produced capital. Sustainable development requires that the optimum mixture of these components be maintained (they do not define "optimum mixture").

With regard to the use of statistics to further the achievement of sustainable development, they stress the need to complement current economic statistics with environmental statistics. They imply support for satellite accounting rather than changes to the central accounts. The concentration on flow accounting that has characterised national accounting in the past is said to be one of its main weaknesses, and that this has diminished the ability for long term management. In the authors' opinions, stock accounting provides a much more solid basis for long term management.

The authors see the need for adapting existing economic analysis tools to include environmental considerations. A planning system based upon forecasting models is advocated and a number of supporting arguments are given. Ideally, economic, environmental and other social issues should be considered simultaneously with due emphasis on all the interconnecting links. In practice this may prove too complex. Thus, an operational planning system needs to be less ambitious. In Norway, there has been good success with the complimentation of the economic planning system with information on emissions of pollutants generated by economic activities. The success of any such scheme depends upon disciplined, coordinated data collection, analysis and interpretation by experts, a competent administrative apparatus and an effective channel of communication from the analytical group to decision makers.

Comment

Lorentsen and Alfsen's discussion of the statistical and analytical needs of sustainable development, although brief, is quite good. A consideration that they do not make clear, however, is that the economic analysis of sustainable development is only one part of an overall effort at achieving the goal of sustainable development for all aspects of social life. I believe that it is important to bear this broader picture in mind when considering the economics of sustainable development.

4. World Commission on Environment and Development. 1987. *Our Common Future*. Oxford and New York: Oxford University Press.

*Norgaard, Richard. 1989. *Linkages Between Environmental and National Income Accounts* Chapter 8 in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.

Description

Norgaard's paper is deals more with the conceptual than the practical issues of natural resource accounting. His major (and important) conclusion is that there is no one approach to to understanding the complex interactions between economic development and the environment. Rather, he argues that multiple methodologies - what he terms conceptual pluralism - are necessary for a more flexible and pragmatic approach to linking environment and economy.

In his argument for conceptual pluralism, Norgaard presents some thoughts on the economic assumptions surrounding sustainable development. First, he notes that if one of the objectives of policy is to improve the chances for sustainable development, then environmental valuations based on information generated from an economy that is less sustainable than desired may be of questionable usefulness. Next, he points out that current market interest rates may not be appropriate for discounting a sustainable future, if achieving that future requires substantial (as opposed to marginal) change in the economic system. Finally, he notes that the techniques used for valuing non-market goods are based on the assumption that the inclusion of these goods in the market-place would not significantly affect relative prices of goods already established in the market. Thus, if environmental goods are significant in comparison to the rest of the goods in the market, the use of standard techniques to value them may not be valid.

Comment

Norgaard's paper presents some very interesting embarkation points for a deeper study of the economics of sustainable development. In particular, his discussion the assumptions surrounding economic sustainability are novel. His ideas raise many questions about the appropriateness of neoclassical economic theory for analysing an economy based on sustainability rather than growth in production. These are valid questions that must be considered before one attempts to use neoclassical theory to analyse a fundamentally different economic

*OECD. 1988. *Natural Resource Accounts: Pilot Study Concerning Forest Resources*. ENV/SE/88.20 Paris: OECD Environment Directorate.

This very short paper briefly outlines the forestry accounts that have been developed in Norway and - even more briefly - in France and Finland. The aspect of this paper of most interest is the proposed common framework for forest accounting. The framework consists of three tables: a traditional forestry mass balance, a sector/commodity balance (input-output oriented) and an industry mass balance. The emphasis is on input-output in the forest industries, as this is regarded as the stage of the total resource flow where resource accounting is likely to provide the most useful new information and insights. The proposed framework accounts for forest resources entirely in physical units, although monetary units could also be used if realistic valuations were available.

*Opschoor, J.B. 1989. *"Towards Sustainable Development: Environmental Change and Macro Indicators"*. OECD Economics and Statistics Department/Environment Department Joint Seminar on The Economics of Environmental Issues, Paper No. 4. Paris: OECD.

Description

Opschoor's paper outlines his thoughts on the current efforts directed at accounting for environmental assets. Section II considers economic welfare and the environment and, in short, comes to the conclusion that the existence of external environmental effects requires that:

- objective or welfare functions must be expanded so that environmental quality as a co-determinant of welfare is economically acknowledged;
- the impacts of economic activity on the quantity and quality of environmental goods be made explicit; and
- production functions be expanded to incorporate environmental externalities.

Section III discusses the implications for environmental impact of the open nature of economic systems.

Section IV (the most relevant for Statistics Canada) discusses the possibilities for constructing macro indicators of sustainability. Opschoor notes that natural capital ought to be regarded as the ultimate foundation of economic production and, therefore, contains a number of essential elements that must be maintained or enhanced for continued economic processes. Time lags, stochastic elements, synergisms and unexpected interdependencies can combine to lead to surprises in economy-environment interactions. This is an argument in favour of erring on the safe side when defining the natural elements necessary for economic production and the "safe" level at which to maintain them.

With regard to the possibilities for correcting GNP to increase its usefulness as a measure of economic sustainability, Opschoor feels that it is quite possible and reasonable to make corrections based on defensive outlays. However, measurements of loss of environmental quality and assets are not so easily made and, therefore, corrections to GNP for these losses are not possible. Opschoor is enthusiastic about Huetting's notion of correcting GNP based on estimates of the costs involved in meeting physical standards for sustainable development (see chapter 6 of Ahmad, El Serafy and Lutz, 1989). The drawback to this method is that it produces an estimate only of potential sustainable income but says nothing of actual economic performance in terms of ecological sustainability.

Opschoor briefly discusses the use of satellite accounts to the SNA to maintain physical data on the environment. He contends that such accounts must be constructed so as to point to the relationship between economic activities, the environmental demands or pressures emanating from these processes and the resulting changes in the qualities and quantities of environmental assets.

Opschoor's own contribution to the debate is his discussion of the need for physical indicators of stocks and quality of the following categories of environmental assets: renewable resources, non-renewable resources, semi-renewable resources and biological diversity. The indicators require a scope wide enough to reflect the notions of sustainability, manageability and integrity. He feels that the number of such indicators must be kept low if they are to be of any use as policymaking tools. Five steps in the formulation of indicators are given, along with a tentative example of one indicator for each of the five areas listed above.

Comment

Opschoor can be accused of undue optimism in his claim that estimates of defensive expenditures can and are being made. This claim is not supported in the general literature. In fact, estimates of defensive expenditures are far from routine, and any that have been made are the result of the efforts of specific research programs. Aside from this, the paper contains many good ideas for economy/environment indicators and a good general discussion of the links between the economy and the environment. His discussion of the unexpected feedback loops that exist between the interaction of human economic activity and the environment is insightful.

*Pearce, David W. 1989. *Sustainable Development: Towards an Operational Definition and its Practical Implications*. OECD Economics and Statistics Department/Environment Directorate Joint Seminar on The Economics of Environmental Issues, Paper No. 3. Paris: OECD.

Description

Pearce's paper discusses two concepts of sustainable development along with some of their implications. The first concept, which Pearce labels the broad concept, requires maintaining a constant stock of capital with substitution allowed among the various types of capital so long as the overall stock is non-declining. The second concept - and the one that Pearce supports - is termed the narrow concept. It requires only that the stock of *natural* capital be non-declining. The latter definition takes into consideration the non-substitutability, irreversibility and uncertainty that characterise the use of some natural resources. Thus, a prudent approach to sustainable development requires that the stock of natural capital be kept non-declining.

Pearce lists and describes a number of implications of each of these definitions. Specifically, he notes that the concept of sustainable development provides good reasons for modifying the GNP to account for environmental damage and defensive expenditures. Pearce contends that a direct implication of sustainable development (however defined) is the need to value resource stocks. He also states the need for a measure of sustainable income, which he defines as measured income less the following: household defensive expenditures, the monetary value of residual pollution, the depreciation of man-made capital and the depreciation of environmental capital.

Sustainable development (however defined) is said by Pearce to imply setting correct prices. For natural resources, correct prices must internalise all environmental externalities and must include a user cost for all depletable resources. A user cost is some value that reflects the foregone opportunity for future generations to use resources that are consumed today. For produced commodities, prices must internalise the ultimate costs of disposing of the product.

Comment

Pearce's narrow definition of sustainability does not include any allowance for increasing population size. The maintenance of natural capital stocks constant is a step toward non-declining welfare only if population remains constant as well. Thus, his definition probably should require non-declining resource stocks per capita.

Pearce also, I believe, places too much emphasis on valuing natural capital. He is somewhat alone among his academic colleagues in this emphasis. The general view in the literature is that there are real limitations in our current abilities to place value on many non-market goods and services. Pearce's disposition to monetary valuation is not surprising however, given his long history of research and practice in the areas of valuation and cost-benefit analysis.

Despite these criticisms, Pearce's paper presents an excellent analysis of the implications of sustainable development for the analysis of economic progress. He makes it clear, as does Opschoor (1989), that unexpected linkages between the economy and the environment provide a good justification for a risk-averse approach to environmental policy.

*Peskin, Henry M. 1976. "A National Accounting Framework for Environmental Assets," in **Journal of Environmental Economics and Management** 2: 255-62.

The content of this paper by Peskin is almost exactly the same as that in his most recent publication on the subject of environmental accounting (see chapter 10 Ahmad, El Serafy and Lutz, 1989 above). The major difference between the two works is Peskin's inclusion of a separate input-output account for the household sector in his later work. This represents an explicit recognition of the role that households play in the productivity of the economy.

*Peskin, Henry M. and Janice Peskin. 1978. "The Valuation of Nonmarket Activities in Income Accounting", in *The Review of Income and Wealth*, 24 (March): 71-91.

Description

In this paper, the authors argue that it is appropriate to use different techniques for valuing goods and services depending upon use to which the values are to be put. Hicks, it is pointed out, proposed the same idea in 1940.⁵ Hicks also proposed the idea that a proxy to the value of the services offered by government could be found in the cost of their provision (although he realised that this was a second best solution). Peskin and Peskin note that this is a common practice among national accountants, but argue that there is not necessarily any reason to believe that the cost of provision of governmental services represents their true social value.

Peskin and Peskin argue that damage to the environment can have three possible values. These correspond to the value to the polluter, to the affected parties and to the difference between these two. These values could be estimated by the area under marginal benefit and marginal damage curves, if these could be constructed. The services provided by the environment, it is suggested, can be valued at the cost to polluters of being denied these services. The authors consider the possibility of using the costs of pollution control by businesses and defensive expenditures (on health care, air filters, fresh paint, etc.) by households to proxy the value of environmental services and damage respectively. They conclude that these expenditures are likely to result in undervaluations because not all pollution is controlled and not all damage is offset.

The authors present a set of income and product accounts that demonstrate how more than one valuation for an entry of a non-marketed commodity can be handled within an accounting framework. They use the environment and in-kind government transfers (food stamps, for example) as examples of non-marketed commodities. (See the entry under chapter 10 of Ahmad, El Serafy and Lutz, 1989 for a more detailed discussion of H. Peskin's method for including the environment in the national accounts.) The authors believe that their accounting system is implementable if the statistician is willing to accept approximations to the valuations that they recommend. Alternative cost estimates, opportunity cost estimates and willingness to pay estimates are all given as means of estimating these values for environmental assets. These methods all result in *full* valuations, which is inconsistent with the *marginal* marketplace valuations of other goods and services in the accounts.

Comment

The authors present an interesting idea in the concept of multiple valuations for non-marketed goods and services. Unfortunately, they do not expand on the concept to indicate where and when particular types of valuations are appropriate. Further, although they claim that their accounting framework is designed with the ability to handle multiple valuations, it is never made clear exactly what it is about the framework that gives it this ability. Thus, they leave an interesting idea incomplete.

With respect to their inclusion of environmental services and damage in the national accounts, the comments made under the entry for chapter 10 of Ahmad, El Serafy and Lutz, 1989 above apply equally to the present article.

5. Hicks, J.R. 1940. "The Valuation of Social Income, in *Economica*, 7, 2 (May).

*Peskin, Henry. 1989. *A Proposed Environmental Accounts Framework* Chapter 10 in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.

Peskin's paper presents his framework for integrating the benefits and disbenefits associated with the use of environmental services into the current SNA. In his framework he is concerned only with including the measurement of the non-marketed services provided by environmental capital.

Peskin firmly believes that all environmental services ought to be given a monetary value, because this is the only means by which anything can be said of their affect on economic welfare. He suggests valuing the benefits associated with environmental service use at the cost to producers of being denied access to their use. The disbenefits associated with the use of environmental assets should be valued at their marginal cost. This accords most closely with market valuations of other goods in the SNA. Further, marginal cost valuation allows the use of the theory of market equilibrium to determine the optimal levels of benefit and disbenefit from the use of environmental assets.

Peskin bases the structure of his accounting system on the U.S. National Income and Product Accounts (NIPA's). He expands the NIPA's to include entries for the input of services from the environment and the output of damages to the environment. He recommends constructing accounts for the industrial, government and household sectors and nature. Each of these sector accounts is expanded to include the value of the inputs of environmental services and the outputs of environmental damage. Another major departure from the traditional NIPA's is Peskin's "nature" sector account. This account includes the input and output of environmental benefits and disbenefits of nature. It is included partly for accounting purposes (nature is the source of all environmental benefits and, therefore, must be included if the accounts are to balance) and partly because the origin of much environmental damage is natural.

Peskin's framework differs from the traditional framework of the NIPA's in its explicit recognition of the productivity of the household sector, in its inclusion of input and output categories for environmental services and in its inclusion of a nature account. From his framework, Peskin develops modified measures of net and gross national product. NNP is reduced (increased) by an amount equal to the depreciation (appreciation) of environmental assets and GNP is reduced (increased) by an amount equal to the value of damage (improvement) to air, land and water. Peskin is careful to note that his framework is arranged so that those who are not interested in his modifications are able to use the accounts in the traditional manner.

Comment

Peskin's paper is one of the more interesting in the World Bank collection. This is because Peskin presents the most complete example of a national accounting framework that includes the natural environment.

A question that Peskin does not deal with is that of the value attributable to an environmental service for which there is no substitute. His concept of valuing environmental services at the cost of being denied their use implies that all such services can be substituted with a non-environmental service. If the cost of being denied the use of an environmental service means that some activity can no longer be carried out, then the value of the service for that activity is infinite. Clearly, this result renders Peskin's valuation method invalid. The reason that Peskin fails to see the flaw in his method is his neoclassical perspective. As Victor (1990a) has pointed out, it is a fundamental tenet of neoclassical economics to accept infinite substitutability between factors of production. In the case of environmental inputs to production this view becomes untenable.

*Peskin, Henry. 1990. *A Survey of Resource and Environmental Accounting Practices in Industrialised Countries*. Draft version, Edgvale Associates.

Description

Peskin has conducted a review of the initiatives (both proposed and implemented) on natural resource and environmental accounting in Australia, Canada, France, Japan, The Netherlands, Norway, West Germany and the United States, as well as the proposed frameworks of Repetto *et al.*, the United Nations Statistical Office and his own work. This review provides a lengthy discussion of the major conceptual and practical issues that pertain to natural resource and environmental accounting along with comments on each of the different framework's approach to these issues. In an appendix to the report, Peskin gives a two to four page summary of the most recent (fall of 1989) state of development of each framework. His major conclusions are:

1. Most systems attempt to address one or both of the major functions of conventional national accounting (ie. the provision of a measure of economic progress and the provision of a coherent data base to support economic policy making). The emphasis that is placed on the two functions differs from system to system.
2. Regardless of the intent of the system, each may succeed in addressing one function more than the other. Thus, the systems should be judged on their actual as much as their intended outcomes.
3. The systems differ widely in their complexity and coverage.
4. The differences in complexity and coverage reflect not only the relative emphasis on the two major functions of national accounting, but also different policy objectives.
5. While the systems may have very different structures, reflecting their different emphases and policy objectives, they may be very similar in their data requirements. Thus, extensive debate over the relative merits of each system, as a prerequisite to implementation, may be unnecessary and counterproductive. (p. 24-26)

*Potvin, Joseph R. 1989. *"Economic Environmental Accounts: A Conspectus on Current Developments."* Report to the Corporate Policy Group of Environment Canada. Ottawa: The Rawson Academy of Aquatic Science.

Description

Potvin's report gives a concise summary of the current and historical development of national accounting and the place of natural resource and environmental accounting within it.

Much of his discussion of current developments centres on the revision of the UN System of National Accounts (SNA) that the UN Statistical Office is currently carrying out. The revised SNA is expected sometime in 1991. It is expected to contain recommendations on developing satellite accounts for natural resources and the environment. Satellite accounting, as opposed to direct integration, is recommended to preserve the integrity of the core SNA.

Potvin presents an interesting discussion of his notion of sustainability (with respect to the economy/environment linkage) and how a revised accounting framework could be used to aid in the achievement of the goals of sustainability. These he lists as: the maintenance of the physical base upon which the productive capacity for satisfying human wants is based, no net loss in ecological productivity, and the maintenance of a suitable balance of trade in materials and energy with other life forms. The first goal can be dealt with in national accounts through the inclusion of a value for the depletion of natural resource. Potvin notes that there are two popular approaches to this. These are the depletion approach (see Repetto *et al.* 1989) and the asset liquidation (user cost) approach (see chapter 3 of Ahmad, El Serafy and Lutz, 1989). Potvin supports the latter, saying that "only [it] will provide useful calculations of net income at the policy, program and project levels." (p. 27)

His second goal of sustainability is related to the deduction of defensive expenditures for environmental protection from GNP. He does not discuss how defensive expenditures may be determined. He does note, however, that the difference between the expenditures actually made and those necessary for achieving sustainable development is a useful proxy to our "environmental deficit". (See chapter 6 of Ahmad, El Serafy and Lutz, 1989 for a similar idea from Huetting).

The third goal, which Potvin describes as a distributional issue, cannot be dealt with through national accounting methods.

Appendices to the paper contain copies of the reports of two expert meetings on environmental accounting. These are described below.

Appendix A - Report of the Joint UNEP/World Bank Expert Meeting on Environmental Accounting and the System of National Accounts, Paris 21-22 November, 1988.

The highlights of this meeting are:

- The revised UN SNA should provide for the maintenance of environmental satellite accounts. Closer incorporation of environmental data to the core of the SNA should not be undertaken until the methodological quandries are cleared up.
- The removal of expenditures for environmental protection from GNP is desirable in principle, but no general consensus exists as to how to effect such a removal.
- For environmental assets that cannot be valued as stocks, physical quantity and quality indicators should be used.

- There are conceptual differences between measuring the depletion of resources that can be physically depleted and those that can be only qualitatively depleted (eg. air and water). The former should be treated in much the same way as man-made assets, and depletion of the latter should be valued at the cost of returning the asset to its original state.
- The concept of "sustainable income" is useful, although it contains conceptual problems. As first steps, research into the removal of measures of the value of depletion/degradation of environmental assets and defensive expenditures from GNP ought to be undertaken.

Appendix B - Draft Report of the First Meeting of the Coordinating Group on Revision of the SNA, United Nations Statistical Office, 23-27 January 1989.

The conclusions of this meeting of importance to environmental accounting are:

- The official manual of the UN System of National Accounts, the "blue book", should contain a discussion of the shortcomings of the national account aggregates in relation to environmental degradation, depletion and defensive expenditures.
- The definition of income in the revised SNA will be: the maximum amount that can be consumed in a period while maintaining initial capital and net capital transfers received in that period intact. This definition follows from Hicks and is close to what is now called sustainable income.

*Repetto, Robert, William Magrath, Michael Wells, Christine Beer and Fabrizio Rossini. 1989. *Wasting Assets: Natural Resources in the National Accounts*. Washington: World Resources Institute.

Description

Repetto *et al.* divide their work into two sections. The first outlines the need for resource accounting and their particular approach to it, and the second describes a study of the application of their approach to Indonesia for the period 1970-1984.

The main theme of the first section is that the failure to include an allowance for the depletion of natural resources is a serious shortcoming of current national accounting practices. The authors argue that this failure "reinforces the false dichotomy between the economy and the "environment" [and] leads policymakers to ignore or destroy the latter in the name of economic development" (p. 3). The growth in output that has been achieved in this way is to no small extent illusory and is inherently unsustainable. Nations that rely on large stocks of natural resources as a primary source of national wealth and income are particularly susceptible to the pitfalls of ignoring resource accounting.

The improper treatment of natural resources in national accounting is, according to Repetto *et al.* a result of two historical facts. First, there was the perception by early neoclassical economists that natural resources were infinitely abundant and "free". Second, the important issues of mass unemployment and controlling the business cycle held the place of prominence in the minds of the economists who developed the basis for our current national accounting practices during the 1930's.

In order to improve the usefulness of the national accounts for policymakers, the authors argue that there must be a value for the depletion of natural resources subtracted from GNP. This would provide a more realistic measure of net national product. The economic justification for their argument is contained in Hicks' definition of income as the amount that a person (nation) can spend while maintaining her/his (its) capital intact. Including a value for the depletion of natural resources also allows the proper calculation of gross and net investment, since the depletion of natural resources can be seen as negative investment.

Repetto *et al.* favour accounting for natural resource depletion in monetary units. This allows policymakers to include depletion estimates directly in economic scenarios. Their choice for a valuation technique is the net price method (see Landefeld and Hines, 1985). This technique values stocks and flows of natural resources at their current unit net price (ie. market price less return to all factors of production including a return to capital) times the quantity of the resource (see Miller and Upton, 1985). It requires knowledge of the opening stock of the resource, the physical additions and depletions from the stock (through human and natural processes) and any change in unit price. The depletion value for the given accounting period is calculated as the change in stock times the average unit price during the accounting period.

Repetto *et al.* apply their method to account for the depletion of Indonesian petroleum, timber and soil resources for the period 1970 to 1984. The results of this preliminary country study show that Indonesia's official GNP growth rate of 7.1 percent per annum is reduced to only 4 percent if depletion of these three natural resources is included in the national accounts. Net domestic investment is shown to be negative in some years when the value of resource depletion is counted as negative investment. This implies that natural resources were being depleted to finance current consumption. The authors note that the information requirements for this study were relatively easily met by researchers spending in total about 1 person-year, mostly in the United States. Some interpolation and extrapolation from limited data was required, but such techniques, the authors note, are already used by national accountants.

Comment

In my opinion, *Wasting Assets* represents perhaps the best available analysis of the need for resource accounting. Anyone wishing to familiarise themselves with the subject should read *Wasting Assets* in its entirety. Equally important, their work is one of the very few attempts in the literature at translating sound theoretical arguments into a practical set of accounts using actual country data. This second step is a very important one in a field where there is much impetus for practical change and little action beyond academic discourse.

One flaw that has been noted by two reviewers (see Kirk Hamilton, *Evaluation of "Wasting Assets"*, Statistics Canada, September 14, 1989 and Victor, 1990b) is Repetto *et al.*'s treatment of discoveries of natural resources as contributions to current income. Hamilton notes that there is a conceptual problem with this treatment, in that it confuses additions to product with additions to wealth. As Victor points out, the practical problem with this treatment is that major discoveries of resources tend to cause large "blips" in measured income, which, in his opinion, "must call the usefulness of this approach into question" (Victor, 1990b: 53).

*Scott, Anthony. 1956. "*National Wealth and Natural Wealth*", in *The Canadian Journal of Economics and Political Science* 22, 3 (August): 373-78.

Description

In this short discussion, Scott presents his argument for the necessity of including natural resources in any measurements of national wealth, as well as for the necessity of including natural resources in the national flow accounts.

Scott bases his argument for the inclusion of natural resources in the measurement of national wealth on the relationship between capital, economic output and natural resources. He notes that "it would be a mistake to believe that the amount of capital per worker or per unit of output is in any way an unequivocal guide to wealth and progress" (p. 374). In fact, an increase in produced capital per worker may be necessary to offset a decrease in the availability of natural resources per worker, and no rise in income need necessarily accompany this increase in capital. To demonstrate this, he uses the example of a young nation, abundant in natural resources, that requires little produced capital to generate a given income. As the nation ages and resources become less readily available, increased capital will be required to maintain the same level of income. "The question to be asked is: Is the increased stock of capital goods per head - which has been measured - accompanied by an increased stock of natural resources per head, or is the former merely compensating for a decline in the latter" (p. 375)?

Natural resources ought to be recorded in the national flow accounts, according to Scott, for two reasons. First, if natural resources are to be accounted for in the wealth accounts, it is necessary to keep track of the flows of discovery and depletion of these resources as well. This is so because the use of the perpetual cumulation technique, which he notes is the easiest way to measure national wealth, requires a time series of investment (discovery) and depreciation (depletion). Second, since the flow accounts can be used as a welfare measure, it is important to include in them the wealth (and embodied welfare) that is contained in natural resources. This is particularly true for a nation, like Canada, that relies heavily on natural resources as a source of wealth and income.

Comment

It is particularly interesting to note that this article was written in 1956, before the discipline of environmental economics could even make a claim to existence. It is clear that Scott was well ahead of other economists in recognising the proper place for resources in the national accounts. That he was well ahead of his time is clear from the fact that Statistics Canada is just now, 34 years later, beginning to operationalise his ideas. His last sentence is telling in this regard: "there will be time and enough for arguments about...policies when more statistics, which show that an effort has been made to measure the national natural wealth and estimate its potentiality for production of income and assurance of survival, have been produced" (p. 378).

The arguments that Scott makes for including natural resources in the national wealth accounts are clearly useful as arguments in favour of Statistics Canada's initiative in this regard. His arguments for including natural resource in the flow accounts, particularly the one relating to the perpetual cumulation technique, are also convincing. They may provide a sound justification for extending Statistics Canada's project to include natural resources in Canada's flow accounts.

*Theys, Jacques. 1989. *Environmental Accounting in Development Policy: The French Experience* Chapter 7 in Ahmad, Yusuf J., Salah El Serafy and Ernst Lutz (eds). *Environmental Accounting for Sustainable Development*. UNEP - World Bank Symposium, Washington: World Bank. 1989.

Description

Theys' paper gives a brief description of the French environmental data system and their system of natural resource (or natural patrimony, as they call it) accounting. This is followed up with some suggestions for using the French experience in the introduction of resource accounting in developing countries.

The French environmental data system is organised into six levels:

- Level I contains heterogeneous data pertaining to specific or non-specific aspects of the environment. This data is of varying quality.
- Level II comprises composite sectoral data on water, atmosphere, land, noise, etc.
- Level III contains state-of-the-environment reports.
- Level IV contains the patrimony accounts, as well as environmental satellite accounts, which are meant to assess national environmental expenditure, its funding and its beneficiaries.
- Level V contains two models, one to assess the effect of the environment on the economy and the other to assess the opposite effect.
- Level VI contains the national accounting aggregates, which to date have not been linked with the lower levels.

According to Theys, the French system of patrimony accounting attempts to cover all facets of nature that can potentially be changed, qualitatively or quantitatively, by human activity. Natural patrimony includes individual components of nature (eg. mineral deposits, soil), ecosystems and territories (whether delimited by geography, politics or grids). The French system is made up of accounts of three main types:

- Component accounts are set up for sub-soil assets, the atmosphere, water and flora and fauna. These accounts are kept in physical units, using material or energy balances to indicate changes in stock resulting from human or natural activity.
- Ecozone accounts are used to account for changes in land use and the status of ecosystems. Remote sensing techniques are required for these accounts.
- Agent accounts are used to record the effects on the natural patrimony of human institutions, which are classified according to the standard categories within the national accounting framework.

Theys notes that the most novel aspect of the French system is its emphasis on accounting for the environment in terms of its three main functions: economic, ecological and social (it is interesting to note his ordering of these functions). The main objective of the accounts is to demonstrate the tradeoffs between these three functions rather than the economic gains (or losses) from the exploitation of nature. Attempts are made to aggregate the data within the accounts. The difficulties in doing this are partially overcome by the creation of equivalent classes of accounts of the assessment level and through the use of monetary or physical units where applicable.

According to Theys, France has been able to produce tangible results from their system over a relatively short period (three years) and at relatively low cost (about US\$100,000), by focusing on only water, forestry, soil and wildlife. Decentralisation of data gathering process has also helped in this respect.

Comment

It is not possible from Theys' brief description of the French system of natural patrimony accounting to make anything but general comments about the usefulness of their approach. It seems to be well thought-out, but the complexity of the data gathering appears daunting. It seems that the French want the best of both worlds by maintaining disaggregated physical accounts on one hand, and aggregated data on the other. It is not clear that the two are compatible; it may be more effective in the long run to concentrate on producing one type of data.

*Victor, Peter A. 1990a. "Indicators of Sustainable Development: Some Lessons from Capital Theory", Background paper for the Workshop on Indicators of Sustainable Development Economics, Ottawa, 27-28 July, 1990. Canadian Environmental Advisory Council.

Description

Victor presents and discusses/criticises the theoretical arguments on capital theory and its relevance for the environment of four "schools" of economics: the neoclassicists, David Pearce and others at the London Centre for Environmental Economics, the post-Keynesians and the thermodynamicists.

Victor notes two important works of the neoclassical school dealing with environmental economics: *Economic Theory of Natural Resources* by Allen Kneese and Orris Herfindahl (1974) and *Economic Theory and Exhaustible Resources* by P. Dasgupta and D. Heal (1979). The most significant conclusion by both sets of authors is that substitution between natural and reproducible capital along with technological progress can prevent resource scarcity from imposing any constraint on economic growth. This is a conclusion with which Victor finds fault. He shows how the assumptions used to arrive at the conclusion are untenable and that under more realistic assumptions the neoclassical viewpoint falls apart.

The main focus of the researchers at the London Centre for Environmental Economics (Victor refers to them as the London school) is the importance for sustainable development of maintaining natural capital intact. Victor finds fault with this approach for two reasons. The first is that it is very difficult to determine exactly what is meant by constant capital. There are four possibilities admitted by the London school: constant physical quantities, constant total value, constant unit value (price) and constant value of resource flows. The problems with aggregating multifarious physical units into a single indicator limit the usefulness of the first possibility. As for the three value-related approaches, Victor is very skeptical of their validity. He writes:

"The price, or prices net of extraction costs, of the resources could be used to value the capital stock but there are several problems with this approach. First of all, there are no market prices for resources such as air, water or wilderness and shadow prices would have to be estimated. Secondly, those prices that do exist may not be useful: they may be affected by market imperfections and taxes, and they may exclude externalities involved with the production and use of the resource. Further, they do not adequately capture the interests of future generations. In other words, they may have little or no normative relevance for valuing the stock of natural capital. Moreover, the use of prices or net prices which reflect conditions at the margin to value entire stocks is itself a highly questionable procedure. It is possible for the real price or net price of a resource to rise over time at the same rate as (or faster than) the rate of decrease in the physical stock of the resource with the result that the value of the resource remaining would stay constant (or rise) until there was none left." (p. 19)

As further evidence of the difficulty involved in measuring natural capital, Victor turns to the post-Keynesian economists and their criticisms of the neoclassical concept of aggregate capital. According to the post-Keynesians, it is impossible to derive separate physical and monetary measures of capital because of the inter-relatedness of value and quantity. Although the post-Keynesians criticised the neoclassical measures of reproducible capital only, Victor claims that the same arguments can be applied to natural

capital as well.

Next, Victor goes beyond his questioning of the feasibility of measuring natural capital to ask if it is even reasonable to consider the gifts of nature as capital in the first place. He turns to the writings of Marshall in this case. According to Marshall, land (gifts of nature) and capital are distinct from one another because the latter can be expanded and diminished more or less at will but the former is essentially fixed in supply. Therefore, land should be treated differently than capital when the welfare of future generations is a consideration.

Victor concludes with a discussion of the thermodynamic view of the economy. For economists who subscribe to this line of thought (Victor includes himself in this category), it is crucial to consider the implications for economic development of the first and second laws of thermodynamics. The first law - the conservation of mass and energy - reminds us that all the material and energy that finds its way into the economy must eventually find its way out as waste. The second law - that the state of a system tends toward disorder (entropy) - reminds us that, in the long run, the ultimate constraint on the economy is the availability of low-entropy matter that can be manipulated into useful goods and services. Thus, the thermodynamicists make it clear that maintaining capital intact is not the only way to approach sustainable development.

Comment

Victor's work is useful because it presents several contrasting views of the economics of sustainable development. He correctly realises that the concept of natural capital is central to sustainable development and, therefore, is an appropriate focus for analysis.

His criticisms of value-related approaches to measuring natural capital are valid. They point to the need to maintain physical as well as monetary resource accounts. He is perhaps too negative in his assessment of the possibility for developing shadow prices for non-marketed resources such as wilderness. There is a great deal of material in the literature that deals with developing these shadow prices, and many economists accept the techniques as valid (see Pearce and Markandya, 1989). Nevertheless, Victor's comments are well worth keeping in mind during Statistics Canada's project.

*Victor, Peter A. 1990b. *Supplementary Economic Accounts for the Yukon Territory: Report to the Yukon Territorial Government*. Toronto: VHB Research and Consulting Ltd.

Victor's study was undertaken, at the request of the Yukon Territorial Government, to determine the options for and feasibility of a number of extensions to the Territorial accounting system. One of the considered extensions is the inclusion of the value of natural resource depletion in the Territory. The report is quite detailed and deals with a fair amount of material that is not of direct relevance to Statistics Canada's project on resource accounting. It includes an extensive annotated bibliography, which includes many of the same papers reviewed in this bibliography.

The results of Victor's study that are of interest to Statistics Canada are as follows:

- The Yukon government should not commit itself to far reaching changes in its accounting system until forthcoming recommendations from the UN Statistical Office and ongoing work at Statistics Canada (within Statistics Canada) are reviewed. Regular contact should be kept with Statistics Canada.
- A Workshop on northern accounts should be held with, among others, experts from Statistics Canada.
- Any modifications or extensions to existing accounts should be made in the form of satellite accounts, for two reasons. First, it is desirable to maintain comparability with other accounting systems. Second, since there is no general agreement on methodologies as of yet, it would be premature to make any direct changes to the accounts.
- In all areas considered, data should be maintained in both physical and monetary units.
- Wealth accounts, in which the stocks of resources (and any monetary or physical changes) are recorded, should be established for the Yukon.
- Depletion of natural resources should be accounted for in the Yukon territorial accounts. Victor indicates his preference for the user cost approach of El Serafy (see chapter 3 of Ahmad, El Serafy and Lutz, 1989), but notes that other methods should be given consideration. Victor also notes that most of the data necessary for including resource depletion in the Yukon Territory's accounts already exists.

*Ward, Michael. 1982. *Accounting for the Depletion of Natural Resources in the National Accounts of Developing Economies*. Paris: OECD Development Centre. Publication No. CD/R(82)3010.

Description

Michael Ward's paper deals with the issues surrounding the proper treatment of the depletion of non-renewable, sub-soil resources within the national accounting framework. The paper is divided into two parts. The first deals with accounting for resource depletion in conceptual terms and the second with the implications for policy in developing nations. An appendix contains three case studies of the impact of ignoring resource depletion in national accounting.

Ward's work contains three prevailing themes. The first is that natural resources should be considered part of the wealth of a nation. Second, the SNA should be modified to distinguish between that part of the value added of the mining sector that is income and that part that is wealth. Third, the state should appropriate the wealth portion of mining receipts to a reserve replacement fund. This fund should be invested to provide an income for the future when the resource is no longer productive. With these themes in mind, Ward discusses several issues of importance to accounting for resource depletion: the estimation of ore reserves, resources as factors of production, economic rent and resource extraction, and the taxation of resource extraction.

Ward discusses in detail the notion of a reserve replacement fund. This is a fund administered by the government that will provide income for the nation when resource reserves are depleted. Funds are appropriated from the sale of natural resources. Ward's intention is that the total wealth of the nation, in monetary terms, should not be reduced by the depletion of natural resources. Thus, the value of the reserve fund at the time of full depletion must be equal to the total value of the resource that the fund is to replace at the time the fund is initiated.

In a case study of the island of Kiribati, Ward provides an excellent example of the dangers of not including resource depletion in national accounts. Kiribati, a small republic, depended during most of this century upon one resource, phosphate, for the vast majority of its national income. No provision was made by the government for supplementary income in the future when the phosphate reserves were depleted. As a consequence, Kiribati's GNP dropped by more than one half during the late 1970's. Ward's thesis is that proper accounting for resource depletion may have alerted the government to the non-sustainability of the national income in time to have prevented this disaster.

Comment

Ward's paper suffers from an overabundance of discussion of issues and a paucity of concrete suggestions for action. For example, his analysis of the issues involved in including natural resources in the national accounts is detailed, but he never gets down to suggesting how to actually make the necessary changes. This is true of many of the points he raises.

One concept that he does elaborate on is that of a reserve replacement fund. Here his mathematical derivation of the value of the annuity necessary to replace the total value of the resource at the point of its depletion is extremely shaky. Nevertheless, the concept of such a fund is interesting and raises many other important questions. First there is the question of how to determine the appropriate total resource value. Ward discusses three possible choices, but makes no recommendation. Second, one must ask whether it is the actual value of the wealth that ought to be kept intact or if it is a certain level of per capita income from that wealth that should be maintained. In either case, it must be remembered that a certain quantity of wealth or income has more weight, in terms of its ability to buy goods and services, now than in the future. Thus, maintaining wealth or income intact is no guarantee of non-declining economic welfare.

These are only two of the questions that come to mind when one considers Ward's reserve replacement fund. In my opinion, he does not deal adequately with these sorts of questions and, therefore, his proposal cannot be viewed as well thought-out.

*World Bank. 1989. *"Improved Accounting of Natural Resources and the Environment for More Sustainable Resource Management: A Research Proposal."* World Bank Environment Department Policy and Research Division.

With this research proposal, the World Bank adopts a position in support of the framework for integrated environmental and economic accounting proposed in Bartelmus, Stahmer and Van Tongeren (1989). The proposal also indicates the Bank's position in support of the concept of satellite accounting for natural resources and the environment.

The Bank's proposed research program - to be conducted under the joint auspices of the Bank, the UN Development Program, the UN Statistical Office and the UN Environment Program - includes several tasks related to operationalising the concepts contained in Bartelmus *et al.*'s framework. These are: the preparation of a preliminary draft manual for the implementation of the framework; conducting a survey of the systems for natural resource and environmental accounting proposed or in practice in industrialised nations (see Peskin, 1990 for a draft of this survey); conducting pilot projects in four developing countries to produce environmental accounts using the framework; and holding an expert meeting to assess the results of the work. The expected output of the research program is a review and evaluation of natural resource accounting experience to date, a collection of the country case studies, and an UN System of National Accounts Handbook on Environmental Satellite accounting.

Section II - Accounting for the Environment

LIST OF REVIEWED PAPERS

*Cremeans, John. E. 1977. *"Conceptual and Statistical Issues in Developing Environmental Measures: Recent U.S. Experience"*, in **The Review of Income and Wealth**, 23, 2 (June): 97-116.

*Drechsler, L. 1976. *"Problems of Recording Environmental Phenomena in National Accounting Aggregates"*, in **The Review of Income and Wealth**, 22, 3: 239-52.

*Firestone, O.J. 1975. *Environmental Accounts*. University of Ottawa Research Paper No. 7505.

*Schafer, Dieter and Carsten Stahmer. 1989. *"Input-Output Model for the Analysis of Environmental Protection Activities"*, in **Economic Systems Research**, 1, 2: 203-227.

*United Nations. 1990. *Informational Disclosure Relating to Environmental Measures: Report of the Secretary General of the Working Group of Experts on International Standards of Accounting and Reporting*. E/C.10/AC.3/1990/5. New York: UN Economic and Social Council.

*Cremeans, John. E. 1977. "Conceptual and Statistical Issues in Developing Environmental Measures: Recent U.S. Experience", in *The Review of Income and Wealth*, 23, 2 (June): 97-116.

Description

"The purpose of this paper is to describe the conceptual and statistical basis of the estimates of United States public and private spending for pollution abatement and control (PAC) prepared by the Bureau of Economic Analysis, U.S. Department of Commerce. The concepts and definitions were designed to ensure comparability with the national economic accounts since much of the analysis of the effects of environmental programs on the economy is conducted with the aid of the accounts. The work to date has been limited to pollution associated with harmful "foreign" substances and forms of energy discharged in the course of production, distribution and consumption. The conceptual basis includes evaluation of benefits, but estimates [during the early 1970's] have been limited to the cost of pollution abatement and control.

Definitions are given for pollution, pollution abatement, direct pollution abatement cost, indirect pollution abatement cost and indirect benefits. A framework for the estimation and presentation of PAC expenditures is developed and the estimate of U.S. PAC expenditures for 1972 and 1973 is presented. A brief chronological summary of the BEA project is also provided."¹

Comment

Cremean's paper provides a thorough conceptual description of one possible framework for analysing the costs and benefits of pollution control in a national accounting context. It is important to note, though, that his framework is entirely contained within the boundaries of the U.S. system of national accounts. Thus, it is constrained to deal only in monetary measures and consider the costs and benefits of pollution abatement to only those agents and entities included in the accounts. Thus, pollution that impacts on wildlife is not considered pollution unless a loss in human welfare can be made explicit as a result of this impact. Further, the health related benefits from pollution reduction will only be apparent in the framework insofar as they contribute in a positive way to economic activity. This could include reduced expenditures for health care and increased productivity, for example, but would entirely exclude those benefits that can not be measured with a monetary yardstick. Examples of the latter include reduced anxiety over one's own and one's family's health and the increased enjoyment of less polluted surroundings.

1. Transcribed directly from the paper's abstract. I felt that any description of my own could not improve upon this one.

*Drechsler, L. 1976. "*Problems of Recording Environmental Phenomena in National Accounting Aggregates*", in **The Review of Income and Wealth**, 22, 3: 239-52.

Description

Drechsler's main point in this paper is that, although there are problems with the way in which national accounting systems deal with damage to environmental assets, there are only very limited possibilities for attaching monetary values to this damage and, therefore, no major changes should be made to the national accounting aggregates in order to accommodate environmental damage. He feels that willingness-to-pay surveys, which are a common way of deriving values for non-marketed environmental goods and services, are not likely to yield reliable results. His main argument in favour of this conclusion is that one can not expect people to give realistic answers to questions about the value of human life and health. Drechsler also rejects the notion that damage to the environment should be valued at the cost of its prevention. There is, he feels, no necessarily direct relationship between the cost of prevention and the true social value of damage to the environment. In any case, the costs of prevention are often not clearly enough defined to justify their use in this manner. Another possibility for valuing environmental damage, also rejected by Drechsler, is valuation at the cost of restoration. Restoration costs are often vaguely defined and in many cases not measurable at all, according to Drechsler. He does allow that there may be one possibility for a limited modification of national accounts based on the level of fines charged to polluting firms. If such fines are broadly proportional to the damage done, and if they are generalised then they may provide a suitable basis for imputing values to environmental damage. In the end, Drechsler concludes that national accounting systems should not be modified, but should be supplemented with physical indicators of the state of the environment.

Comment

I found some of Drechsler's arguments to be convincing and others not so. In particular, I do not share his overly pessimistic view of the usefulness of willingness-to-pay surveys. For one, not all WTP surveys rely on questions relating to health and life, as Drechsler seems to imply. Further, there have been quite a lot of empirical studies done using WTP since the middle 1970's (when Drechsler was writing) that have demonstrated the method's validity (see Pearce and Markandya, 1989). I am not convinced that placing monetary values on environmental degradation is possible in all instances (for example, the loss of a species can not be valued), but for other types of damage the possibilities are much better. I do agree with Drechsler's criticism of the valuation of environmental damages at the cost of prevention or restoration. His argument that the relationship between these costs and the social cost of environmental damage is tenuous is convincing. However, I find Drechsler's suggestion of valuing damage at the value of fines imposed on polluters to be even less theoretically sound. While it is possible that fines could be set at a level to reflect the social cost of environmental damage, it does not seem likely that this is the case in practice.

*Firestone, O.J. 1975. *Environmental Accounts*. University of Ottawa Research Paper No. 7505.

Firestone's paper presents brief reviews and comments on twelve methods of environmental accounting that were developed during the early 1970's. The emphasis of most of the models is on accounting for the costs of pollution generation and the benefits of pollution abatement. Many of the methods use some form of extended input-output model, while others use a materials balance approach. The remainder fall under a variety of categories. This review could be effect means of familiarising oneself quickly with the fundamental aspects of a variety of approaches to environmental accounting.

*Schafer, Dieter and Carsten Stahmer. 1989. *"Input-Output Model for the Analysis of Environmental Protection Activities"*, in **Economic Systems Research**, 1, 2: 203-227.

Description

Schafer and Stahmer's paper discusses means for revealing data on the value of defensive environmental expenditures in the Federal Republic of Germany using the national input-output table. Their method makes it possible to determine not only the direct expenditures on environmental protection, but the indirect expenditures as well. Two indicators of the importance of environmental protection to the overall economy, one based on the ratio of defensive expenditures to value added and the other on the number of persons employed in protection activities, are developed. The authors also describe an improved welfare measure based on the removal of defensive expenditures from national product.

Comment

This paper goes a step beyond most of the rest of the literature on the subject of removing defensive expenditures from the national product. While most authors are content to advocate the removal of defensive expenditures on the basis of theory, Schafer and Stahmer present an in-depth analysis of how to do so. This second step makes their work an important contribution to the literature.

*United Nations. 1990. *Informational Disclosure Relating to Environmental Measures: Report of the Secretary General of the Working Group of Experts on International Standards of Accounting and Reporting*. E/C.10/AC.3/1990/5. New York: UN Economic and Social Council.

This document describes the results of a survey of the environmental reporting and accounting practices of 20 corporations from 10 nations. The results are directly significant for natural resource accounting practices at the national scale since the information gathered regarding environmental expenditures for inclusion in national accounts must originate in the reports and/or accounts of the firms that undertake such expenditures. The general finding of the analysis is that very few corporations currently report or account for environmental expenditures separately from their normal practices. Furthermore, there is little action on the part of national governments to implement changes in accounting procedures that would require firms to do so. Thus, it would appear, from these results at least, that determining the extent of environmental outlays from corporate accounts and reports will not be easy.

Section III - Natural Resource Valuation

LIST OF REVIEWED PAPERS

*Boskin, Micheal J., Marc S. Robinson, Terrance O'Reilly and Praveen Kumar. 1985. "New Estimates of the Value of Federal Mineral Rights and Land," in **The American Economic Review**, 75, 5 (December): 923-936.

*Brown, Thomas C. 1984. "The Concept of Value in Resource Allocation", in **Land Economics**, 60, 3 (August): 231-46.

*Hartwick, John M. 1989. *Natural Resources, National Accounting and Economic Depreciation*. Queen's University (mimeo)

*Hartwick, John M. 1990. *Allowing for Economic Depreciation of Natural Resource Stocks in National Accounting and Sustainable Development*. Queen's University. (mimeo)

*Landefeld, J. Steven and James R. Hines. 1985. "National Accounting for Non-Renewable Resources in the Mining Industries," in **The Review of Income and Wealth**, 31, 1 (March): 1-20.¹

*Levhari, David and Nissan Liviatan. 1977. "Notes on Hotelling's Economics of Exhaustible Resources," in **The Canadian Journal of Economics** 10, 2 (May): 177-92.

*Miller, Merton H. and Charles W. Upton. 1985. "A Test of the Hotelling Valuation Principle," in **Journal of Political Economy**, 93, 1 (February): 1-25.

*Pearce, D.W. and Anil Markandya. 1987. "Marginal Opportunity Cost as a Planning Concept in Natural Resource Management," in **The Annals of Regional Science**, 21, 3 (November): 18-32.

*Peters, Charles M., Alwyn Gentry and Robert O. Mendelsohn. 1989. "Valuation of an Amazonian Rainforest," in **Nature**, 339, 6227 (June 29): 655-656.

*Soloday, John J. 1980. "Measurement of Income and Product in the Oil and Gas Mining Industries," in Dan Usher (ed.) **Studies in Income and Wealth, Volume 45: The Measurement of Capital**. Chicago: University of Chicago Press.

1. See also the entry under the same title in section I of this bibliography.

*Boskin, Micheal J., Marc S. Robinson, Terrance O'Reilly and Praveen Kumar. 1985. "New Estimates of the Value of Federal Mineral Rights and Land," in *The American Economic Review*, 75, 5 (December): 923-936.

Description

The authors divide their paper into two sections, one dealing with the value of U.S. government leased mineral rights and the other with the value of U.S. government owned land. Only the former is described below.

Boskin *et al.* claim that the value of U.S. government leased mineral rights (they consider only oil and gas) must include both the value of proven reserves and what they term "economically recoverable undiscovered reserves" (p. 924). As a justification for this position, they cite several negative implications of ignoring undiscovered reserves for the accuracy of national wealth estimates.

Boskin *et al.*'s method for valuing mineral rights is simple. First they note that there are two sources of income that the U.S. government receives from leased mineral rights: bonus payments received upon leasing the rights, which do not depend on existence or size of reserves; and royalty payments that are based upon the value of the resource extracted during a given year. The total value to the government of oil and gas reserves on federal land, then, is the present value of the future stream of bonus payments plus the present value of the future stream of royalties from both proven and undiscovered reserves. This total value need be calculated only for a base year. The value in future years can be calculated simply by adding capital gains (or losses) and subtracting the value of bonus payments and royalties received. Capital gains are equal to the change in price times the previous year's value.

To determine the present value of future royalty payments, Boskin *et al.* make the "strong and convenient" (p. 926, emphasis added) assumption that resource prices will rise at the rate of interest. They justify this assumption on the basis that the OPEC cartel has agreed to allow real oil prices to rise at 3 percent annually (which they must implicitly assume is equal to the real rate of interest). This assumption allows them to ignore the complication of determining future extraction schedules when calculating reserve values. Thus, they are able to very simply calculate the present value of future royalty payments as: $\text{royalty rate} \times \{\text{current price} \times \text{total reserves}\}$.

To calculate the present value of future bonus payments, the authors use another highly simplifying assumption: the future ratio of bonus payments to royalty payments will be the same as that during the period 1954-1981. Historical data is available to determine this ratio for the this period. Once this is done, it is a simple matter to calculate the present value of future bonus payments based on the present value of future royalty payments calculated as above.

Using this method, the authors come up with a total present value of U.S. government on and off-shore oil and gas reserves (proven and undiscovered) of US\$819.3 billion. This sum, the authors note, is larger than any other single component of U.S. national wealth.

Boskin *et al.* admit that there are two sources of potential error in their estimates. The first is the reliability of the U.S. Geological Survey's estimates of total economically recoverable oil and gas reserves. Using high and low (95% and 5%) confidence bounds for these estimates, the authors calculate a present value range of US\$582.1 billion to US\$1134.9 billion. This is, they admit, a large range, but even the low value shows that oil and gas rights have significant value. The other source of potential error is in their assumption that prices will rise at the rate of interest. They carry out a sensitivity analysis for this assumption and find that their estimates are somewhat sensitive to the assumed rate of price increase. For instance, a 1 percent rate of price increase (rather than the 3 percent rate that they assume) results in a 15 percent decrease in the present value of proven reserve royalties and a 45 percent decrease in the present

value of undiscovered reserves.

Comment

The work by Boskin *et al.* is one the very few, and probably the most thorough, attempts at valuing a nation's natural resources. For this reason, it is an important contribution to the literature. This fact notwithstanding, however, there are some problems with the work.

First, the authors' presentation of US\$819 billion as the *absolute* value of the U.S. government's mineral rights is misleading. In reality, there is some degree of uncertainty associated with this value that is related to the probability attached to the existence of the undiscovered reserves. Thus, the authors should have presented their result as a range of possible values based on reasonable upper and lower estimates of potential reserves. They present such a range in their discussion of error sources. The very large range (over US\$500 billion) of possible values that they admit is evidence that the inclusion of undiscovered reserves in wealth estimates can cause serious losses of precision in national wealth estimates. Thus, it can be argued that only proven, developed reserves should be included in national wealth estimates.¹

Second, Boskin *et al.* do not provide a defensible justification for their assumption that resource prices will rise at the rate of interest. True, they do make some attempt at this by citing an agreement by the OPEC cartel to control the rate of oil price increases,² but this argument carries little weight. While they do not make explicit reference to it, it appears that the authors are making use of the much earlier result of Hotelling³ in this assumption. However, Hotelling's analysis applied to *net* prices of resources, whereas Boskin *et al.* assume that the *total* price will rise at the rate of interest. Thus, I can see no defense for their assumption, and, since their entire valuation method depends on its validity, I must conclude that their results are also undefensible.

These are only two of a number of problems with Boskin *et al.*'s work. In the end, its importance as a contribution to the literature is mainly as an incentive to other researchers to improve upon it.

-
1. There are also uncertainties associated with the size of proven reserves. Thus, confining wealth estimates only to proven reserves does not completely eliminate imprecision. However, it seems reasonable to assume that the degree of precision with which proven reserve sizes are known is great enough that the precision of the overall wealth account will not be seriously impaired by the inclusion of proven natural resource reserves.
 2. Recent events in the Persian Gulf ought to warn against making any assumptions about the oil prices based on agreements among Middle Eastern states.
 3. Harold Hotelling, in his seminal article (Hotelling, 1931) on the economic theory of exhaustible resources, used an elegant mathematical argument, well grounded in accepted economic theory, to prove that (under certain very restrictive conditions) the net price of exhaustible resources could be expected to rise at the rate of interest. He then went on to show that, as a result, one could ignore extraction schedules when valuing resource stocks.

*Brown, Thomas C. 1984. "The Concept of Value in Resource Allocation", in **Land Economics**, 60, 3 (August): 231-46.

Description

Brown's paper deals with two main topics. The first is the concept of value in general terms, and the second the appropriateness of economic values as the basis for making resource allocation decisions.

His discussion of value starts from the premise that individual preferences are the source of all value, from which he develops three preference-related value realms. The conceptual realm deals with the source of preference, which Brown describes as one's held values. These are one's primary values from which all secondary values follow. The relational realm describes the preference relationship between the holder of the preference and some object for which a preference can be established. Value in the relational realm cannot be observed; it is only at the feeling level. The final realm is the object realm, which deals with the expressed preference for one object over another. These preferences are what Brown terms assigned values and it is in this realm that monetary values as expressed in market prices belong.

Assigned values (which Brown spends the rest of the paper discussing) are said to depend on (1) the person's perception of the object and all other relevant objects, (2) the person's held values, and (3) the context of the valuation. Whether or not assigned values in general are an appropriate basis for resource allocation decisions depends on the appropriateness of these three factors to the decision. For assigned values to be an appropriate basis, the valuing agent's perception of the object must be clear and precise, and the held values of the valuing agent must correspond to the held values of the constituency for which the allocation decision is being made. With respect specifically to the appropriateness of market prices as a value basis for resource allocation decisions, Brown concludes that their appropriateness is diminished because (1) they are the result of individual decisions that may not be made with the broader social constituency in mind, (2) they rely on ability to pay for expression, (3) they rely on market transactions that are strongly influenced by social settings, and (4) it is not at all clear that actions demonstrated in the market place are made even with one's own welfare firmly in mind.

Brown presents the results of an experiment to determine if the context of valuation actually does affect the values placed on commodities or environmental amenities. Based on the results of this experiment, he concludes that both the constituency that the valuer has in mind (ie. personal or societal) and the measure of expression (ie. a dimensionless scale or units of money) affect personal valuations.

In the end, Brown concludes that what is needed is a concept of assigned value that is more closely related to the welfare of the broad constituency which will be affected by decisions based on the assigned values. He feels that there is a need for a concept that goes beyond the narrow focus on income and monetary transactions of modern welfare economics. He suggests that such a concept of value could be achieved by placing valuers in a context where they would be forced to consider the broader social good.

Comment

Brown presents a well argued case that market prices may be inappropriate as bases for resource allocation decisions. Economists will counter-argue that, while there may be some flaws in the use of market derived values for collective decision making, there is no better means of revealing preferences. I must confess that I find both arguments somewhat convincing. The question that remains to be answered is to what extent the use of market prices for resource allocation distorts this allocation away from that which would result if a "societal" assigned value could be used. If this distortion is not large, then the use of market prices does not likely result in major misallocations of resources and vice versa.

*Hartwick, John M. 1989. *Natural Resources, National Accounting and Economic Depreciation*. Queen's University (mimeo)

This paper by Hartwick presents mathematical proofs that the depreciation of non-renewable and renewable resource assets can be valued using Hotelling rents. Through his analysis, Hartwick is able to show that the Hotelling rents resulting from the exploitation of these resources are the appropriate measures of economic depreciation. These should be subtracted from GNP to arrive at the correct value for NNP. Hartwick extends his analysis to the valuation of the depreciation of environmental service assets. This, he concludes, should be valued at the marginal cost of increasing the rate of natural pollution abatement times the units of abatement achieved.

*Hartwick, John M. 1990. *Allowing for Economic Depreciation of Natural Resource Stocks in National Accounting and Sustainable Development*. Queen's University. (mimeo)

Hartwick's position is that the current principles of national accounting are correct and adequate for dealing with issues of environmental degradation and natural resource depletion. The problem in the past has been that these principles have not been properly applied. Specifically, the capital consumption allowance that has been used to adjust GNP to NNP has mistakenly not included a measure of the depletion of natural resources and environmental services. Hartwick presents a proof (Appendix III) that for competitively efficient firms extracting homogenous stocks of non-renewable resources the proper value of the economic depreciation is the Hotelling rent (that is, the average time-period price net of extraction and exploration costs times the quantity of the resource exploited during the period). This is the value, according to Hartwick, that should be deducted from GNP to account properly for the depletion of non-renewable resources. Hartwick then goes on to argue that the same principle can be applied to renewable resources to calculate the economic value of the depletion of these in excess of their natural growth during any given time period.

With respect to the services provided free of charge by the environment to the economy, Hartwick notes that the lack of proper prices for these services must be considered a failure of the market, and second-best solutions sought. He again advocates using a variation of Hotelling rents to value the loss in environmental services, using a shadow price times quantity of service lost for each service. He includes a large caveat for this proposal. If a measure of the depreciation of environmental services is to be removed from GNP, then there must also be an allowance for the unpriced production and consumption of services from the environment. Otherwise, GNP will be underestimated.

*Landefeld, J. Steven and James R. Hines. 1985. "National Accounting for Non-Renewable Resources in the Mining Industries," in **The Review of Income and Wealth**, 31, 1 (March): 1-20.⁴

This paper describes three alternatives for valuing reserves and changes in reserves of mineral and energy natural resources. The methods discussed are: the present value method, the land-price method and the net-price method.

The present value method, although it is commonly used, is found to give widely varying results depending upon the assumptions made about future rates of return and prices. The uncertainty involved in making these predictions is found to be too great for the method to be of much worth.

The land-price method is based on the economic theory that under long-run equilibrium and perfect competition, the purchase price of physical capital should equal its present value. Landefeld and Hines adapt this theory somewhat to allow for the fact that much resource-bearing land is not bought and sold, but leased. The advantage of this method is that it does not require any uncertain predictions of the future. However, the authors found that it tended to underestimate the value of reserves, for a number of reasons.

The net-price method simply states that the value of optimally managed natural resource reserves will tend to grow at the rate of return on comparable capital assets. This reduces the estimation of the value of reserves to the product of the net-price-per-unit times the quantity of reserves. Landefeld and Hines note that the assumptions that underlie the net-price method are not fulfilled in natural resource markets.

In the end, Landefeld and Hines conclude that all three methods of valuing natural resources are tenuous at best, but that the land-price estimates seem the most reasonable when measured against the average market rate of return .

4. See also the entry under the same title in section I of this bibliography.

*Levhari, David and Nissan Liviatan. 1977. "Notes on Hotelling's Economics of Exhaustible Resources," in *The Canadian Journal of Economics* 10, 2 (May): 177-92.

Description

The authors discuss the implications of two assumptions made by Hotelling in his original analysis of the economics of exhaustible resources.⁵

Specifically, Hotelling assumed that the output of a mine falls to zero in the last time period of operation and that all mines are exploited to physical (as opposed to economic) exhaustion at the end of their lives. These two assumptions are found by the Levhari and Liviatan to be unnecessarily restrictive and not in keeping with the reality of mineral exploitation. The major conclusion of their paper is that when there are cumulative extraction effects on marginal extraction costs (ie, when extraction costs rise with the quantity extracted), the rate of growth of marginal profit is not equal to the rate of interest (r) (as in Hotelling's famous result), but is less than r and bears no particular relationship to it. The authors derive several other results, but they are of less significance.

Comment

Levhari and Liviatan's analysis of Hotelling's rule is important. It serves to point out that under less restrictive (and more realistic) assumptions than Hotelling's, his famous result does not hold. Thus, the practical usefulness of Hotelling's result is questionable.

5. Hotelling, Harold. 1931. "The Economics of Exhaustible Resources," in *The Journal of Political Economy*, 39, 2: 137-75.

*Miller, Merton H. and Charles W. Upton. 1985. "A Test of the Hotelling Valuation Principle," in *Journal of Political Economy*, 93, 1 (February): 1-25.

Description

Miller and Upton discuss a less well-known implication of Hotelling's rule, which they call the Hotelling Valuation Principle (HVP):

"in a world where mineral prices follow the Hotelling [rule], the value of reserves in a currently operating, optimally managed deposit depends mainly on the current period prices and extraction costs, regardless of when the reserves are extracted" (p. 3).

The significance of this result for the valuation of reserves of exhaustible resources is great, since it means that reserves can be valued at current net price per unit times quantity. This eliminates the need for prediction of future prices, extraction schedules, discount rates, demand and so on, thus highly simplifying the exercise.

In order to test empirically the predictive power of the HVP, the authors regress reserve values determined using the HVP against the stock-market value of 39 U.S. oil and gas producing companies. They find that, for the period 1979-1981, the HVP values for mineral deposits account for a substantial portion of the variation in market values of these firms. The estimated values are also found to be better indicators of the market value of petroleum properties than two other methods that are widely used.

The authors address (at least briefly) some of the major sources of concern with the use of the HVP. They find that the assumption of constant marginal extraction costs has no major effect on their results. The effect of non-competitive pricing (due to market power or government regulation) is also found to have little effect. Taxes are found to have an effect on the accuracy of the HVP, but the authors are unable to quantify this effect.

Comment

Miller and Upton's study of the Hotelling Valuation Principle is very thorough. They go to great lengths to test the statistical validity of their assumptions and are very careful in all aspects of their analysis, except for one. They do not explicitly state what comprises the operating cost that they subtract from the unit resource price to arrive at the unit net resource price. Hotelling's original analysis requires that the net price be net of all operating costs, including a return to the capital used in the extraction process. As Yvan Gervais of Statistics Canada has pointed out, it is not clear whether the extraction cost data that Miller and Upton used contains an allowance for this return. If they do, then Miller and Upton's results are valid. If not, the reserve values calculated using the HVP are too high, and their results are not valid.

*Pearce, D.W. and Anil Markandya. 1987. "Marginal Opportunity Cost as a Planning Concept in Natural Resource Management," in *The Annals of Regional Science*, 21, 3 (November): 18-32.

Description

Pearce and Markandya present the concept of marginal opportunity cost (MOC) as the proper way to value small depletions in natural resource stocks.

MOC comprises the direct costs of finding, extracting and processing resources, plus the costs arising from external ecological effects of resource use, and a user cost that reflects the foregone opportunity of the future use of non-renewable resources (or renewable resources that are not managed for sustained yield). Thus, the MOC is an attempt to measure the true cost of the depletion of one unit of a natural resource.

The calculation of the second and third components of MOC, the external costs and the user costs, require a great deal of information, some of it subjective, which the authors admit is not easily collected. Specifically, information regarding ecological interactions and the future demand for scarce resources present significant difficulties. The calculation of these two costs also requires the choice of a discount rate. With respect to this choice, the authors note that the use of a rate based on the market rate of interest or an inferred rate of time preference is likely (especially in developing economies where the market tends to heavily discount the future in favour of gains in the current period) to lead to too high a discount rate. This in turn will result in an undervaluation of external and user costs, with a corresponding undervaluation of MOC and policy that favours too much resource extraction. Unfortunately, the authors do not suggest how to choose an appropriate discount rate.

Among other uses, Pearce and Markandya recommend the use of MOC as a means of valuing the depletion of natural resources for inclusion in national accounts. They argue that the external and user costs of resource depletion should be subtracted from the value of the marketed resource. User cost is analogous to a capital consumption allowance and should be subtracted from net income. External costs are a mixture of present and future costs, and their treatment as either gross and net income is not clear.

Comment

I agree in principle with Pearce and Markandya that the proper cost of resource depletion must include a measure of the external ecological costs and user costs to future generations. However, I am not as optimistic as they are that reasonable estimates of these costs can be formulated. There are significant problems in demonstrating clear-cut cause and effect relationships between resource depletion and external ecological effects, for example. The calculation of a user cost requires a means of predicting future demand for the resource in question, as well as the potential for technological change and resource substitution in the future. These are not trivial, and may be impossible, to estimate. Furthermore, the choice of an appropriate rate at which to discount the future is not a subject of common agreement. Since the use of MOC requires the choice of a discount rate, there is no doubt that the values derived from its use will not gain general agreement. In spite of these comments, MOC would be, I believe, a useful means of valuing natural resource depletion if it could be made operational.

*Peters, Charles M., Alwyn Gentry and Robert O. Mendelsohn. 1989. "Valuation of an Amazonian Rainforest," in *Nature*, 339, 6227 (June 29): 655-656.

Description

Peters *et al.* present two estimates of the net present value (NPV) of a hectare of Peruvian rainforest. The first estimate is based on the selective extraction of several varieties of marketable timber on a sustained yield basis at 20 year intervals. The estimated net present value of the forest in this case is US\$490 per hectare.⁶ The second estimate is based on the sustained yearly harvest of marketable fruits and natural rubber from the forest. Peters *et al.* calculate a NPV of US\$6,330 per hectare for this type of production. The value of a one-off felling of the timber contained in the forest is calculated to be US\$1000. It is noted that this type of felling causes significant damage to the forest and future revenue from fruit and rubber would be eliminated or drastically reduced. It is not indicated whether "selective" cutting of timber on a sustained basis also damages fruit and rubber producing trees.

Comment

This article makes it clear that it is important to bear in mind the fact that a forest has more value than just that as sawn timber when evaluating forest resources.

Peters *et al.*'s study benefits from the fact that market prices exist for both the forest resource as timber and for the alternative uses of the forest. In the case of Canadian forests this is not so. Aside from their timber value, Canadian forests can be valued for, among other things, the recreation they provide, for their contribution to a healthy environment, and for their cultural importance. However, none of these valuable qualities are bought and sold in a marketplace and, therefore, an indirect method of valuation is required. Techniques for estimating the value of forests as recreation areas do exist and are defensible. Unfortunately, the same cannot be said for the other forest qualities mentioned. Thus, it is difficult (perhaps impossible) to place a monetary value on all the possible sources of value contained within Canadian forests. Nevertheless, it is important to include all measurable sources of value when calculating the value of our forests. Not doing so runs the risk of seriously undervaluing our forest resources.

6. Rick Moll of Statistics Canada feels that Peters *et al.* have used the wrong formula to calculate the net present value of the forest income stream. The authors' formula is where V is the value of the harvest, r is the rate of interest and t is the period between harvests. Rick feels that the proper formula is This is based on the Faustmann formula, a formula commonly used for calculating NPV in forestry. Using the latter formula, Rick calculates a NPV of US\$180.

*Soloday, John J. 1980. "*Measurement of Income and Product in the Oil and Gas Mining Industries*," in Dan Usher (ed.) **Studies in Income and Wealth, Volume 45: The Measurement of Capital**. Chicago: University of Chicago Press.

Description

In this paper Soloday attempts to measure income and product in the United States oil and gas mining industries according to economic definitions of income and value. Currently, income and product in this sector are based on accounting definitions of investment and depreciation that are more a result of tax considerations than economic theory. Soloday's concept of income is the value of consumption plus the increase in wealth. His definition of depreciation is the "diminution over time of the value of the originally anticipated revenue stream, at its originally anticipated discount rates and expected prices" (p. 371). He applies these concepts to oil and gas production over the period 1948 to 1974 to calculate the value of new discoveries, acquisition costs, acquisition capital gains, the total value of oil and gas reserves and the value of depreciation in each year. His results indicate that official estimates of gross product in the oil and gas mining sector were 53% too low and that official estimates of depreciation were underestimated by over two times his estimates.

Comment

Soloday's technique for determining the value of oil and gas stocks requires the prediction of future oil and gas revenue. This revenue stream is then discounted, using three different discount rates, to yield a present value for the stock. Thus, to the extent that his predictions turn out not to be accurate his method will yield incorrect resource values. Furthermore, his use of three different discount rates reflects the difficulty involved in choosing one, objective, defensible rate of discount. His method suffers, as a result, from a degree of subjectivity.

The above comments notwithstanding, Soloday's work is a very thorough attempt at valuing stocks of oil and gas. It should, therefore, be given due consideration as a possible method for use in Statistics Canada's project.

Section IV - Valuation of the Environment

LIST OF REVIEWED PAPERS

Folmer, H. and E. van Ierland. 1989. *Valuation Methods and Policy Making in Environmental Economics*. Amsterdam: Elsevier.

Hufschmidt, M.M., D.E. James, A.D. Meister, B.T. Bower and J.A. Dixon. 1983. *Environment, Natural Systems and Development: An Economic Valuation Guide*. Baltimore and London: The Johns Hopkins University Press.

Maler, K.G. and Ronald E. Wyzga. 1976. *Economic Measurement of Environmental Damage: A Technical Handbook*. Paris: OECD.

Markandya, A., D.W. Pearce and R.K. Turner. 1989. *"The Use of Benefits Estimates in Environmental Decision Making: Case Study on the United Kingdom."* Paris: OECD Environment Directorate.

*Pearce, David W. and Anil Markandya. 1989. *Environmental Policy Benefits: Monetary Valuation*. Paris: OECD.

Folmer, H. and E. van Ierland. 1989. *Valuation Methods and Policy Making in Environmental Economics*. Amsterdam: Elsevier.

Location: Environment Canada Library, Place Vincent Massey Call number: TD 178.5 S78 no. 36

Part I of this book contains four chapters dealing with the valuation of environmental public goods. Chapter 2 is a study of the use of three valuation methods applied to a well defined market for water quality on two similar cottage lakes in Iowa. The three methods used are:

1. A site valuation based on a comparison of the values of real estate on the two lakes.
2. A market valuation based on the opinion of realtors in the area as to the cause of the observed differences in property prices between the lakes.
3. A contingent valuation of property owners on the lakes to determine their willingness to pay for improved water quality and the willingness to accept a decrease in water quality.

Chapter 3 discusses two basic issues. The first is the willingness to pay for more than a single change in the preservation of endangered species. The second is an examination of the possibilities and limitations of questionnaire techniques in determining the willingness to pay for public goods in a risky world.

Chapter 4 discusses microeconomic techniques for the multiple use, (recreation and commercial forestry) analysis of a forest.

The final chapter of the section is a case study of the expected marginal increase in Norwegian fresh water fish populations due to a decrease in acid deposition. A detailed description of the organisation of the survey and questionnaire that were used is given.

Hufschmidt, M.M., D.E. James, A.D. Meister, B.T. Bower and J.A. Dixon. 1983. *Environment, Natural Systems and Development: An Economic Valuation Guide*. Baltimore and London: The Johns Hopkins University Press.

Location: Dept. of Finance Library Call number: HC79 E5E584

Hufschmidt *et al.*'s work is a very thorough development of the methodology required for valuing environmental quality. Their discussion follows logically from the principles of valuation to the analysis of the effects of environmental quality on receptors to the techniques for placing a value on these effects. The book contains many examples, both real and hypothetical, of the use of these techniques, and each chapter is followed by an exhaustive reference list.

Chapter 6 discusses techniques for valuing environmental quality from the perspective of the benefits that it provides. The techniques discussed fall into three broad categories

1. Those based on observable market values or productivity. These techniques can be used when the quality of the environment has a direct effect on a market price or the productivity of a process.
2. Those based on substitute (surrogate) or complimentary goods (also referred to as the hedonic pricing approach). The price of the substitute or complimentary good or service can be used to value the environmental good or service. Examples of this technique are the property value, wage differential and travel cost approaches.
3. Those based on surveys or bidding games. These techniques rely on surveys or bidding games to reveal individual's preferences, and, hence, the value they place on, for environmental quality.

Chapter 7 is a discussion of the possibilities for valuing environmental quality based on the costs involved in maintaining or restoring it. It is sometimes necessary to use this approach since it is not always possible to determine values for benefits. The authors note that it is the full *economic* costs, as distinct from the financial costs, that must be determined. Economic costs include a value for the opportunity costs associated with any undertaking. The techniques discussed in chapter 7 are:

1. The preventive expenditures method, which attempts to determine a minimum value for an environmental quality based upon empirical data showing how much people have paid to eradicate or reduce adverse effects on this quality.
2. The replacement cost approach, which gives a minimum value to environmental goods and services at the cost of their replacement.

Chapter 8 discusses the use of input-output analysis and linear programming as means of revealing and valuing the relationship between the economy and environmental quality.

Maler, K.G. and Ronald E. Wyzga. 1976. *Economic Measurement of Environmental Damage: A Technical Handbook*. Paris: OECD.

Location: Department of Finance Library Call number: HC79 P55M23

"[This work] is designed to acquaint those who develop environmental policy with the concept and utility of environmental damage functions. [It] indicates those situations where monetary damage functions can be applied usefully in the development and execution of environmental policy. [It] reviews and suggests methods which can be used to estimate environmental damage functions and it provides guidelines to ensure that the resulting estimates are meaningful and in accord with economic principles" (p. 12).

Maler and Wyzga use environmental damage functions as a means of estimating the relationship between levels of environmental quality and monetary estimates of the environmental damage associated with these quality levels. They concentrate on two types of monetary damage estimates: estimates of financial losses and estimates of amenity losses. Financial losses, the changes in expenditure that result from changes in environmental quality, are relatively easy to measure if physical damage can be measured. Amenity losses present more difficult conceptual measurement problems because they are not directly observable. The authors discuss the use of willingness to accept compensation surveys, simulated demand curves, marketplace reactions and litigation results as possible means of valuing losses in amenity.

Markandya, A., D.W. Pearce and R.K. Turner. 1989. *"The Use of Benefits Estimates in Environmental Decision Making: Case Study on the United Kingdom."* Paris: OECD Environment Directorate.

Markandya *et al.*'s paper outlines the political decision-making framework within which benefit estimation takes place in the U.K. It then goes on to describe briefly the context and results of six case studies in which various benefit estimation techniques were used to place a value on (mainly) environmental services. Hedonic pricing, contingent valuation, willingness-to-pay and value-of-damages-avoided are the most commonly used techniques. The paper also discusses attempts that have been made by the U.K. transportation authority to place a value on human life.

The authors conclude that, although benefit estimation was considered with some skepticism in the U.K. during the 1970's, the techniques are gaining wider acceptance and use of late.

*Pearce, David W. and Anil Markandya. 1989. *Environmental Policy Benefits: Monetary Valuation*. Paris: OECD.

Description

This publication provides a concise overview of the current state of the art in the area of benefit estimation techniques as they apply to environmental policymaking. The techniques that are discussed are: hedonic property prices, wage risk studies, contingent valuation methods, travel cost approaches (all of these are considered direct valuation approaches) and indirect dose-response approaches.

Hedonic property price methods are a means of determining how much of a property value differential is due to a particular environmental quality and, thereby, to infer how much people are willing to pay for an improvement in this particular quality. Wage risk studies attempt to place a value on life based upon wage differentials paid to workers in jobs of differing relative riskiness. Contingent valuation methods are means of determining individual's willingness to pay for environmental improvement (or to accept environmental degradation) based upon their responses to hypothetical market situations. Travel cost methods attempt to derive individual's willingness to pay for the use of natural recreation areas through an analysis of the time and money spent travelling to and using a particular recreational area.

Indirect methods of benefit estimation are used when it is thought that people are unaware of the effects that pollution causes. The techniques involve calculating an estimate of the damage actually done by pollution and then applying a price to this damage. The methods are indirect in that they do not involve the direct observation or simulation of individual's activities.

For each of these methods of benefit estimation, Pearce and Markandya discuss the basic theory, its strong and weak points and give some examples of its use in practice.

Comment

This short publication is an excellent summary of the state-of-the-art in benefit estimation techniques. Anyone wishing to quickly familiarise themselves with this topic is well advised to read the work.

ENVIRONMENTAL DISCUSSION PAPERS

The National Accounts and Environment Division has a series of environmental discussion papers, which are available to national accounts users without charge. A list of these papers currently available is presented below. For copies of any of these papers, contact the NAED client services representative, Mitzi Ross, at 613-951-3819 or write to her at Statistics Canada, 22nd Floor, R.H. Coats Building, Tunney's Pasture, Ottawa, Ontario, K1A 0T6.

DOCUMENTS DE TRAVAIL SUR L'ENVIRONNEMENT

La Division des comptes nationaux et de l'environnement a à sa disposition une série de documents de travail sur l'environnement, que les utilisateurs des comptes nationaux peuvent obtenir sans frais. Une liste des documents disponibles est présentée ci-dessous. Pour obtenir des copies d'un ou de quelques-uns de ces articles, communiquez avec Mitzi Ross du service à la clientèle de la DCNE (613-951-3819) ou lui écrire à Statistique Canada, 22ième étage, édifice R.H. Coats, Tunney's Pasture, Ottawa, Ontario, K1A 0T6.

1. Hamilton, Kirk (July 1989): *Natural Resources and National Wealth*.
2. Hamilton, Kirk and Douglas Trant (December 1989): *Statistical Aspects of the Application of Geographic Information Systems in Canadian Environment Statistics*; Journal of Official Statistics 1989, vol. 5, no. 4, pp. 337-348.
3. Smith, Robert (September 1990): *An Annotated Bibliography of the Resource and Environmental Accounting and Valuation Literature*.
4. Gervais, Yvan (October 1990): *Some Issues in the Development of Natural Resources Satellite Accounts: Valuation of Non-renewable Resources*.
5. Mitchell, Bruce and Kirk Hamilton (December 1990): *Environmental Statistics at Statistics Canada*, also available in translated version: *La statistique environnementale à Statistique Canada*.
6. Mitchell, Bruce and Kirk Hamilton (May 1991): *Canadian Experience in the Development of Environmental Surveys*.
7. Hamilton, Kirk (August 1991): *Proposed Treatments of the Environment and Natural Resources in the National Accounts: A Critical Assessment*.
8. Hamilton, Kirk (September 1991): *Organizing Principles for Environment Statistics*.
9. Smith, Robert (September 1991): *The Linkage of Greenhouse Gas Emissions to Economic Activity Using an Augmented Input/Output Model*.
10. Trant, Douglas (February 1992): *The Changing Rural Environment: A Look at Eastern Ontario's Jock River Basin*.
11. Born, Alice (May 1992): *Development of Natural Resource Accounts: Physical and Monetary Accounts for Crude Oil and Natural Gas Reserves in Alberta, Canada*.
12. Trant, Douglas (May 1992): *Land Use Change Around Riding Mountain National Park*.



1010186426

Technical Series

rique

The National Accounts and Environment Division has a series of technical paper reprints, which are available to national accounts users without charge. A list of the reprints currently available is presented below. For copies of any of these papers, contact the NAED client services representative, Ms. Mitzi Ross, at 613-951-3819 or write to her at Statistics Canada, 22nd Floor, R.H. Coats Building, Tunney's Pasture, Ottawa, Ontario, K1A 0T6.

La Division des comptes nationaux et de l'environnement a à sa disposition une série de tirés à part d'articles techniques, que les utilisateurs des comptes nationaux peuvent obtenir sans frais. Une liste des tirés à part disponibles est présentée ci-dessous. Pour obtenir des copies d'un ou de quelques-uns de ces articles, communiquez avec Madame Mitzi Ross du service à la clientèle de la Division des CNE (613-951-3819) ou lui écrire à Statistique Canada, 22ième étage, édifice R.H. Coats, Tunney's Pasture, Ottawa, Ontario, K1A 0T6.

1. "Laspeyres, Paasche and Chain Price Indexes in the Income and Expenditure Accounts", reprinted from *National Income and Expenditure Accounts*, fourth quarter 1988.
2. "Technical Paper on the Treatment of Grain Production in the Quarterly Income and Expenditure Accounts", reprinted from *National Income and Expenditure Accounts*, first quarter 1989.
3. "Data Revisions for the Period 1985-1988 in the National Income and Expenditure Accounts", reprinted from *National Income and Expenditure Accounts*, first quarter 1989.
4. "Incorporation in the Income and Expenditure Accounts of a Breakdown of Investment in Machinery and Equipment", reprinted from *National Income and Expenditure Accounts*, third quarter 1989.
5. "New Provincial Estimates of Final Domestic Demand at Constant Prices", reprinted from *National Income and Expenditure Accounts*, fourth quarter 1989.
6. "Real Gross Domestic Product: Sensitivity to the Choice of Base Year", reprinted from *Canadian Economic Observer*, May 1990.
7. "Data Revisions for the Period 1986-1989 in the National Income and Expenditure Accounts", reprinted from *National Income and Expenditure Accounts*, first quarter 1990.
8. "Volume Indexes in the Income and Expenditure Accounts", reprinted from *National Income and Expenditure Accounts*, first quarter 1990.
9. "A New Indicator of Trends in Wage Inflation", reprinted from *Canadian Economic Observer*, September 1989.
10. "Recent Trends in Wages", reprinted from *Perspectives on Labour and Income*, winter 1990.
11. "The Canadian System of National Accounts Vis-à-Vis The U.N. System of National Accounts", reprinted from *National Income and Expenditure Accounts*, third quarter 1990.
12. "The Allocation of Indirect Taxes and Subsidies to Components of Final Expenditure", reprinted from *National Income and Expenditure Accounts*, third quarter 1990.
13. "The Treatment of the GST in the Income and Expenditure Accounts", reprinted from *National Income and Expenditure Accounts*, first quarter 1991.
14. "The Introduction of Chain Volume Indexes in the Income and Expenditure Accounts", reprinted from *National Income and Expenditure Accounts*, first quarter 1991.
15. "Data Revisions for the Period 1987-1990 in the National Income and Expenditure Accounts", reprinted from *National Income and Expenditure Accounts*, second quarter 1991.
16. "Volume Estimates of International Trade in Business Services", reprinted from *National Income and Expenditure Accounts*, third quarter 1991.
17. "The Challenge of Measurement in the National Accounts", reprinted from *National Income and Expenditure Accounts*, fourth quarter 1991.
18. A Study of the Flow of Consumption Services from the Stock of Consumer Goods, reprinted from *National Income and Expenditure Accounts*, fourth quarter 1991.

1. "Les indices de prix Laspeyres, Paasche et en chaîne dans les comptes des revenus et dépenses", tiré à part de *Comptes nationaux des revenus et dépenses*, quatrième trimestre 1988.
2. "Document technique sur le traitement de la production de céréales dans les comptes trimestriels des revenus et dépenses", tiré à part de *Comptes nationaux des revenus et dépenses*, premier trimestre 1989.
3. "Révisions des données de la période 1985-1988 dans les comptes nationaux des revenus et dépenses", tiré à part de *Comptes nationaux des revenus et dépenses*, premier trimestre 1989.
4. "Incorporation dans les comptes des revenus et dépenses d'une décomposition de l'investissement en machines et matériel", tiré à part de *Comptes nationaux des revenus et dépenses*, troisième trimestre 1989.
5. "Les nouvelles estimations provinciales de la demande intérieure finale en prix constants", tiré à part de *Comptes nationaux des revenus et dépenses*, quatrième trimestre 1989.
6. "Produit intérieur brut en termes réels: sensibilité au choix de l'année de base", tiré à part de *l'Observateur économique canadien*, mai 1990.
7. "Révisions des données de la période 1986-1989 dans les comptes nationaux des revenus et dépenses", tiré à part de *Comptes nationaux des revenus et dépenses*, premier trimestre 1990.
8. "Les indices de volume dans les comptes des revenus et dépenses", tiré à part de *Comptes nationaux des revenus et dépenses*, premier trimestre 1990.
9. "Un nouvel indicateur des tendances de l'inflation par les salaires", tiré à part de *l'Observateur économique canadien*, septembre 1989.
10. "Tendances récentes des salaires", tiré à part de *l'Emploi et le revenu en perspective*, hiver 1990.
11. "Le système de comptabilité nationale du Canada et le système de comptabilité nationale des Nations Unies", tiré à part de *Comptes nationaux des revenus et dépenses*, troisième trimestre 1990.
12. "La répartition des impôts indirects et des subventions aux composantes de la dépense finale", tiré à part de *Comptes nationaux des revenus et dépenses*, troisième trimestre 1990.
13. "Le traitement de la TPS dans les comptes des revenus et dépenses", tiré à part de *Comptes nationaux des revenus et dépenses*, premier trimestre 1991.
14. "L'introduction des indices de volume en chaîne dans les comptes des revenus et dépenses", tiré à part de *Comptes nationaux des revenus et dépenses*, premier trimestre 1991.
15. "Révisions des données de la période 1987-1990 dans les comptes nationaux des revenus et dépenses", tiré à part de *Comptes nationaux des revenus et dépenses*, deuxième trimestre 1991.
16. "Estimations en volume du commerce international des services commerciaux", tiré à part de *Comptes nationaux des revenus et dépenses*, troisième trimestre 1991.
17. "Le défi de la mesure dans les comptes nationaux", tiré à part de *Comptes nationaux des revenus et dépenses*, quatrième trimestre 1991.
18. Étude sur le flux des services de consommation générés par le stock de biens de consommation, tiré à part de *Comptes nationaux des revenus et dépenses*, quatrième trimestre 1991.

