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# National Income Accounts and the Environment

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# NATIONAL INCOME ACCOUNTS AND THE ENVIRONMENT

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## INTRODUCTION

Recent declines in the gross national product (GNP) growth rate and associated measures of the nation's economic performance have caused public concern. Such concern is understandable because many individuals automatically associate material well-being with social well-being—a human failing existing at least from biblical times. Few professional economists would claim, however, that any economic indicator actually measures social well-being. Even the noneconomist knows that there has to be more to life than a large GNP.

The GNP and other measures of economic performance such as the net national product (NNP) and the national income (NI) are aggregations of entries in the nation's official income and product accounts. These are prepared by the Bureau of Economic Analysis in the Department of Commerce using data from the Census Bureau and many other public and private sources. While there is probably general agreement that these measures fail to reflect many facets of social well-being, they do indicate to a large degree what society does care about. Just how accurately they do this is a matter of debate.

The debate takes several forms and covers many related issues. A current version centers on the relationship between economic growth and the burdens environmental regulations place on industry, households, and government. The issue is whether the gains to society expected from the regulation—gains which generally do not show up in GNP—are being more than offset by losses in GNP precipitated by the regulations. This debate thus moves from the general question of how much of the "lost GNP" represents a loss in social well-being to the more specific one of how well the GNP reflects environmental change.

This paper addresses these issues by considering the following questions:

To what extent are changes in quality of the environment already appropriately measured by the GNP?

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Is it feasible to modify conventionally measured GNP so that it can more accurately account for environmental change?

Is it desirable to do so?

## TO WHAT EXTENT DOES GNP CURRENTLY MEASURE CHANGES IN THE ENVIRONMENT?

Gross national product is a measure of the nation's annual production of goods and services. Given the narrowness of this definition, it is understandable to question how it is possible for an index of production to measure well-being in general or changes in the environment in particular. However, the production being measured consists of goods and services that do have some relation to the environment. About 63 percent of GNP is accounted for by the production of consumption goods, 17 percent by the production of investment goods (that is, heavy machinery, new plants, and so forth), and the remainder is largely governmental services.

Since it is likely that changes in both the physical environment and environmental policy responses will affect consumption and investment decisions as well as governmental activity, we can expect these changes to be reflected by some changes in the GNP. The trouble is that the size, or more important, the direction of the resulting changes in GNP are not obvious. If a rising GNP is associated with a "better life," then presumably GNP should fall as environmental quality decreases, all other things being equal. Similarly, GNP should rise in response to successful efforts to clean up the environment. Whether a rise or fall occurs depends on a host of factors that are masked by the GNP statistic.

Historically, periods of rapid industrialization have been associated with declines in air and water quality. Before concluding that a rise in GNP *necessarily* implies a deteriorating physical environment, it is necessary to look closely at the composition of the goods and services produced as the GNP changes. For example, if the service sector of the economy (insurance, legal, medical, other professional services) accounts for a large portion of the increase in GNP, as has been the case in recent years, air and water degradation may be minimal.

Of course, if a portion of the increase in GNP consists of goods consumed in order to "defend" against environmental degradation, then such consumption could be taken as evidence that the quality of the environment has declined. While such goods as paint, air filters, detergents, and health services could be purchased for such "defensive" purposes, it is not clear that was indeed the purpose of the purchase. Similarly, the increase in health services in recent years could

be a sign of a wealthy society rather than a polluted one. In short, the problem is to separate "defensive" from ordinary expenditures.

Besides looking at the composition of goods embodied in an increased GNP, it may also be necessary to consider the composition of increases in pollutants before drawing conclusions on the amount of environmental degradation associated with an increase in GNP. Some pollutants are worse than others and increased emissions of some pollutants may have been offset by a decrease in others that are more obnoxious. As serious as automobile pollution may be, health problems associated with the more organic form of horsepower used in the 19th century may have been far worse.

Before concluding that environmental degradation and GNP increases are necessarily associated, we should consider the feedback effect of a poor physical environment on the ability to produce. A dirty environment can affect, not only the health of the work force and thus the productivity of labor, but also the productivity of capital equipment. For example, factories on Lake Erie and Lake Ontario report their water intake pipes clogged by algae, whose excessive growth is due to nutrient pollutants such as phosphorus and nitrogen compounds.[1]

We turn now to the reverse association—that is, between an *improvement* in environmental quality and the GNP. In the absence of policies to protect or improve the environment, a discussion of this relationship would parallel that above. Thus, no firm conclusion could be drawn without looking at changes in the composition of GNP, the composition of pollutants, and whether the improvement increased labor and capital productivity.

However, the issue is even more complicated if the reduction in pollution is partially or totally a result of environmental policies. The expenditures generated by these policies will have different effects on GNP, depending on who undertakes them and whether they are for investment goods or noninvestment goods and services such as labor, fuel, consumption items, or raw materials used in production.

For technical reasons (GNP includes final, not intermediate goods and labor), business expenditures for the operation and maintenance of pollution control equipment will tend to show up as a reduction in GNP. In effect, these expenditures divert labor and material away from items counted in the GNP and toward the production of a cleaner environment, which is not counted in the GNP. However,

1. A. Sudar, The Social and Economic Implications of Eutrophication in the Canadian Great Lakes Basin (January 1978) (unpublished report prepared for the Pollution from Land Use Activities Reference Group, Environment Canada).

similar operation and maintenance expenditures by consumers or by the government will show up as a change in the composition of GNP, but not necessarily in its level.

Expenditures to purchase pollution control equipment, whether by business, consumers, or the government, may not have any short-term effects on GNP. Indeed, GNP may increase slightly if these outlays serve to employ previously unemployed workers. Yet the longer term effects could be in the opposite direction. Some observers believe that for each 1 percent of capital diverted to the production of a cleaner environment from production of goods and services conventionally included in the GNP, ordinary GNP will eventually decline about one-third of 1 percent.[2] The fact that short-term and long-term effects may be in opposite directions explains why statements that "environmental regulation creates more jobs than it destroys" are compatible with seemingly contradictory statements that "environmental regulation dampens productivity and growth."

## MODIFYING CONVENTIONALLY MEASURED GNP

There have been a number of efforts over the years to modify the conventional income and product accounts and the GNP in order to obtain either a better measure of production or of social well-being.[3] Those investigators explicitly interested in measures of well-being have recognized the problems discussed above and have suggested ways of more adequately accounting for the environment.

The best-known alternative measure of well-being is the measure of economic welfare (MEW) devised by Nordhaus and Tobin.[4] The MEW is largely a rearrangement of items of the national accounts. In addition, however, they have added imputations for items not covered in the conventional national accounts and the GNP: household work, leisure, and the services consumers derive from durable goods such as autos, boats, and appliances. Nordhaus and Tobin also include a correction (in the negative direction) for the "disamenities of urbanization." This correction is intended to include the unpleasantness of environmental pollution along with other characteristics of urban life

2. Labor diversion is even more serious under the same analysis. Presumably a 1 percent diversion of labor will lead to a 0.66 percent decline in output.

3. These efforts have been summarized in B. Campbell & J. Peskin, Expanding Economic Accounts and Measuring Economic Welfare: A Review of Proposals (Oct. 1979) (report prepared for the Measures of Economic Well-Being Branch, Environmental and Nonmarket Economics Division, Bureau of Economic Analysis, Department of Commerce, Washington, D.C.).

4. W. Nordhaus & J. Tobin, *Is Growth Obsolete?*, in ECONOMIC GROWTH (F. Thomas Juster ed. 1972).

that are disamenities to some: "litter, congestion, noise, insecurity, large buildings, and advertisements offensive to taste."

Since it is not possible to determine how much of Nordhaus and Tobin's correction is due to environmental deterioration alone, the MEW approach does not appear to be a satisfactory procedure for accounting for environmental changes. In addition, one could question the underlying premise behind the statistical procedure used to obtain the urban disamenity estimate: namely, that a higher urban income, relative to rural incomes, is necessary to compensate for urban disamenities. It is not difficult to imagine how urban incomes could be higher even if urban life were perceived to be superior to rural life. If, for example, urban living space were limited, and as a consequence, the supply of certain labor skills were also limited, higher urban incomes might simply reflect strong demand relative to limited supply of both labor and land.

In any event, the urban disamenity correction proposed by Nordhaus and Tobin appears to be fairly small. Of the total MEW of about $1200 billion that Nordhaus and Tobin estimate for 1965 (1958 dollars), the disamenity correction has a negative value of about $35 billion or 3 percent of the total. However, ordinary GNP in 1965 was about $618 billion (in 1958 dollars). Thus Nordhaus and Tobin's disamenity correction relative to GNP is more significant, about 6 percent of the total. Again, it should be remembered that the portion of this percentage due solely to environmental factors is unknown.

The Economic Council of Japan has attempted a more direct approach to account for the environment as part of their own measure of national well-being.[5] Like Nordhaus and Tobin, their net national welfare (NNW) measure is largely a rearrangement of national account items supplemented by imputations for the services of government capital, consumer durables, leisure, and other nonmarket activities. While there is a negative adjustment for urbanization, the environment is treated separately. First, there is a negative adjustment for "environmental maintenance costs." These are defined to equal the costs of operating and maintaining pollution control equipment plus the annualized capital costs of purchasing it. (This is analogous to the annual costs the Council on Environmental Quality reports each year in its *Annual Report.*) Second, there is a negative adjustment for remaining pollution not yet controlled. This adjustment is estimated by the approximate cost of reducing pollution to 1955 levels.

5. Economic Council of Japan, NNW Measurement Committee, *Measuring Net National Welfare of Japan* (April 30, 1974) (report prepared for the Japanese Ministry of Finance, Tokyo).

While there is a superficial appeal to subtracting both of these items from GNP to obtain a better welfare measure, the approach is deficient on two grounds. First, it confuses the costs of pollution control with the social gains from pollution control. In principle, the gains can be far greater or far less than the costs. Second, as the environment gets cleaner, the "environmental maintenance costs" will increase. This increase may be matched by a decrease in the estimate of the adjustment for remaining pollution since remaining pollution will be less. As a result, the Japanese NNW may increase, show no change, or even decrease when environmental quality improves. This makes it an unsatisfactory modification to the GNP accounts.

In contrast to the Nordhaus–Tobin MEW, the environmental adjustment of the Japanese NNW is fairly substantial. For 1965 it was about 12 percent of their GNP. Interestingly, the Japanese have a separate correction for urban disamenities. In contrast to the MEW, the urban disamenities are confined to time costs of commuting and the cost of traffic accidents. Nevertheless, the value of this negative correction is about 3 percent of NNW—about equal to the percentage share of urban disamenity in the Nordhaus–Tobin MEW.

## A FRAMEWORK FOR MODIFYING THE TRADITIONAL ACCOUNT STRUCTURE

Disappointment with the ability of the conventional accounts to measure environmental changes has led to some additional suggestions for modifying the aggregate measures. For example, Olson, among others, has suggested that GNP be reduced by an amount equal to the social damage from pollution.[6] This reduction, in principle, would equal the amount of consumption expenditures incurred to "defend" against the disamenities, plus an additional amount people would be willing to pay to eliminate any remaining disamenities.

Other adjustments are possible. Herfindahl and Kneese have suggested that GNP be reduced by an amount equal to pollution control expenditures in the belief that this would be a suitable proxy for the amount of social damage caused by the pollution.[7] It also could be argued that NNP should be reduced by an amount that reflects any deterioration in the stock of environmental capital. This concept of the environment as a stock of a depreciable capital that generates in-

6. M. Olson, *The Treatment of Externalities in National Income Statistics*, in PUBLIC ECONOMICS AND THE QUALITY OF LIFE 219 (L. Wingo & A. Evans eds. 1977).

7. O. Herfindahl & A. Kneese, *Measuring Social and Economic Change: Benefits and Costs of Environmental Pollution*, in THE MEASUREMENT OF ECONOMIC AND SOCIAL PERFORMANCE 441 (M. Moss ed. 1973).

come forms another basis for modifying the standard accounting system.

This framework is based on the view that the environment, like the capital embodied in ordinary plant and equipment, generates useful services.[8] Also, like ordinary capital, environmental capital is in finite supply, and, for this reason, has a "scarcity" value. Unlike ordinary capital, the services of environmental capital are not bought and sold in the marketplace. This lack of a market not only means that some market substitute must be found for allocating these services among those in society demanding them, it also means that the true "scarcity" value of these services cannot be readily observed.

Suppose for the moment that a price could be set for environmental capital services and that it would be possible to vary this price and observe the quantity of services demanded. In other words, a demand curve could be established for each user of the service. Let us further suppose that the environmental service in question is that provided by clean air and consider the demand for this service by business. Except to serve the needs of its employees, business does not demand clean air per se. Clean air, however, provides a readily available source of oxygen for combustion and a convenient place to dispose of the waste products associated with this combustion as well as certain wastes associated with other processing.

Some of these uses are, of course, more essential than others. The "oxygen" service of clean air is critical since the business could not function without it. The demand for this service is thus very high. The disposal service, on the other hand, is less crucial—economists would say more marginal—since other options for reducing the amount of wastes disposed to the air are available to the business. These include the installation of pollution control equipment and changes in the level and mix of products.

However, these other options are expensive either in terms of equipment costs or in forgone sales and profits. If a price were established for the use of clean air, the business would presumably pay this price as long as it were slightly less than the unit cost of the least costly alternative waste reduction option.

Thus, the air offers a valuable disposal service in addition to other valuable services. These are, in principle, just as important to the business as labor, capital, and material services. The modified accounting framework to be discussed below acknowledges explicitly this

8. For purposes of this paper, environmental capital will be defined to include the air and those portions of land and water which are not privately owned. Thus, the term "environment" refers to only the *physical* environment.

similarity between environmental capital services and the services of other inputs that are purchased.

To clearly distinguish consumers from businesses, assume for the moment that consumers do not demand the air for disposal purposes —an assumption that eventually will be dropped. Assume they demand clean air for life support, good health, and aesthetics. As noted above, some of the business demand for air—the demand for disposal services—is marginal since alternatives for these services exist. It is controversial to make a similar assumption that some portion of the demand for clean air by consumers is marginal. Many persons believe that clean air is a "right" and that the concept of a finite price for clean air is beyond imagination. Yet it is essential to assume that consumers would be willing to pay a finite price for clean air if the damages from air pollution are to be measured. This assumption is necessary to implement our suggested accounting structure.

If the services of environmental capital are to be entered into a national accounting structure, two accounting entries will be required. One will describe the productive services the environment provides to business and other consumers of environmental services. This will be entered on the left-hand side of the business accounts and the consolidated national account, along with the other productive inputs. A second entry will describe any resulting loss of environmental services or damage to consumers resulting from the use of the environment by business and other sectors. Since this damage can be viewed as a "bad" produced by the business (as opposed to a "good"), it will be entered negatively on the right-hand side of the business accounts and the consolidated national account, along with the other components of output. Since, in general, these two entries will not be equal, a balancing entry will be required if accounting balance is to be maintained.

These entries are not presently captured in the accounts since the services of the environment are not priced. However, policy changes could alter the situation. For example, if effluent charges were imposed on business, the value of the environmental services to them will be reflected in their ordinary accounting. If these charges cover the full value of the services, no additional input entry would be required. Similarly, if polluters were required to compensate consumers suffering environmental damage, and if these payments covered the full extent of the damage, an additional output entry would also not be required. Such policies involving pollution charges and compensation appeal to economists since they promote efficient allocation of environmental resources. Another attractive feature is that they would help correct the faulty treatment of the environment in the

current national accounts. However, the ensuing discussion will assume that such a "full coverage" effluent fee-compensation scheme does not exist.

## A MODIFIED ACCOUNTING STRUCTURE[9]

The above framework suggests a procedure for modifying the conventional income and product accounts so that they can capture certain features of the environment that are presently ignored. New account aggregates can be defined that better reflect changes in the demand for environmental services and in environmental quality.

The accounts modified to reflect environmental services are rather similar to those in the conventional accounting structure. The consolidated GNP account is a combination of production accounts in four sectors: industries, governments, households, and the environment (nature). In order to make them more understandable to those familiar with the conventional accounts, conventional as well as new entries are used. There are no new entries for current pollution control outlays since these are already included in the conventional accounts. However, it is probably useful to identify these costs separately, as has been done by the Bureau of Economic Analysis (Department of Commerce) since 1972.

### *Industries*

The typical industry account shown in Table 1 contains three new entries that ordinarily would be absent from a conventional account of the industry's inputs and outputs. Item 11 accounts for environmental services and item 16 accounts for damages.[10] Environmental services, because they are "free," are like a subsidy to the industry. Therefore, they are entered as a negative input. Item 12 is the arithmetic difference between items 16 and 11. It assures that the modified accounts balance. Since it is defined as the difference between the service benefit of the environment and the "disbenefit" of environmental damage, it is labeled "net" environmental benefit.[11] The

9. This section is based on H. Peskin & J. Peskin, *The Valuation of Nonmarket Activities in Income Accounting*, 24 REV. OF INCOME & WEALTH 71 (March 1978) and H. Peskin, *A National Accounting Framework for Environmental Assets*, 2 J. ENVT'L ECON. & MANAGEMENT 255 (1976).

10. These are all damages–not just to consumers, but to any agents in the economy that are damaged (including other businesses).

11. Net environmental benefit is shown as the difference between the environmental damages entry and the services entry. However, since damages and services are entered negatively, it actually is equal to the absolute value of the services less the absolute value of the damages.

TABLE 1

INDUSTRY PRODUCT ACCOUNT (TYPICAL SECTOR)

| Input | Output |
|---|---|
| 1. Purchases from other industrial sectors | 13. Sales to private sector (current account)<br>a. To other industries<br>b. To households<br>c. Exports |
| 2. Compensation of employees and proprietors (incl. rental income) | 14. Sales to government |
| 3. Profits with inventory valuation and capital consumption adjustment<br>a. Profits tax<br>b. Profits after tax<br>c. Inventory valuation and capital consumption adjustment | 15. Sales for gross investment |
| 4. Net interest | |
| 5. Imports | |
| 6. Transfer payments | |
| 7. Indirect taxes | |
| 8. Subsidies received (–) | |
| 9. Capital consumption allowances | |
| GROSS INDUSTRY SECTOR INPUT | GROSS INDUSTRY SECTOR OUTPUT |
| 11. Environmental services (–)<br>a. Air<br>b. Water<br>c. Land | 16. Environmental damages (–)<br>a. Air<br>b. Water<br>c. Land |
| 12. Net environmental benefit (1.16–1.11)* | |
| MODIFIED GROSS INDUSTRY SECTOR INPUT | MODIFIED GROSS INDUSTRY SECTOR OUTPUT |

*1.16, 1.11, etc., means item 16, item 11, etc., table 1.

modified industry account input and output totals equal the conventional input and output totals less the absolute value of environmental damage.

*Governments*

As we noted earlier, the conventional governmental product account is rather simple. Similarly, the modified account shown in Table 2 is very simple since it contains only those additional entries that ac-

TABLE 2

GOVERNMENTAL PRODUCT ACCOUNT

| Input | Output |
|---|---|
| 1. Purchases from industry (1.14) | 7. Governmental goods and services |
| 2. Compensation of employees | |
| 3. Imports | |
| GOVERNMENTAL INPUT | GOVERNMENTAL OUTPUT |
| 5. Environmental services (–)<br>a. Air<br>b. Water<br>c. Land | 8. Environmental damages (–) |
| 6. Net environmental benefit (2.8–2.5) | |
| MODIFIED GOVERNMENTAL INPUT | MODIFIED GOVERNMENTAL OUTPUT |

count for the government's use of the environment, the resulting damage, and the necessary balancing entry.

*Households*

The conventional accounts assume very little household production takes place (primarily accounted for by nonprofit institutions and the services of domestics). The focus of conventional accounts on activities that reflect market transactions precludes consideration of the "outputs" from keeping up a house, preparing meals, raising children, and do-it-yourself projects.[12]

Households are far more important in our modified accounts. Primarily because of the automobile, households account for a substantial portion of environmental damage and associated use of the air for disposal services. Households also enjoy the services of the water and, as a result, contribute to water pollution, although to a much lesser extent than in the case of air pollution.[13]

Households are unique among the producing sectors since most of the environmental damage they cause (as a result of their consumption of environmental services) is inflicted within the household sec-

12. The one major nonmarket activity associated with households that is included in the accounts—the imputation for the implicit "rents" from owner-occupied housing—is included in the business sector.

13. Sewered households do not, in our system, pollute the environment. Sewered wastes are inputs to municipal treatment works, an industrial sector, which is credited with any resulting environmental damage.

tor itself. In contrast, industries and government tend to inflict damage outside their own sector. The modified household account is shown in Table 3.

TABLE 3
HOUSEHOLD PRODUCT ACCOUNT

| Input | Output |
|---|---|
| 1. Purchases of intermediate goods from industry (1.13.b) | 9. Services to households<br>a. Nonprofit institutions<br>b. Domestics |
| 2. Compensation of employees and proprietors | |
| 3. Imports | |
| 4. Surplus of nonprofit institutions | |
| 5. Capital consumption allowances | |
| GROSS HOUSEHOLD INPUT | GROSS HOUSEHOLD OUTPUT |
| 7. Environmental services (–)<br>a. Air<br>b. Water<br>c. Land | 10. Environmental damages (–)<br>a. Air<br>b. Water<br>c. Land |
| 8. Net environmental benefit (3.10–3.7) | |
| MODIFIED GROSS HOUSEHOLD INPUT | MODIFIED GROSS HOUSEHOLD OUTPUT |

*Nature*

The modified accounting system differs most markedly from the conventional system in its inclusion of nature as a producing sector. (See Table 4.) Nature is shown to produce all environmental asset services and to "consume" environmental damages. Nature also must be included because it generates a substantial portion of environmental damage. For example, a large portion of dissolved solids in water have a natural origin and, on average, naturally generated particulates and nitrogen oxides (other than nitrogen dioxide) greatly exceed the manmade production of these air pollutants.[14]

Some persons may have a philosophical objection to the idea of nature as a "polluter," but the concept is required for practical

14. *See, e.g.*, U.S. ENVT'L PROTECTION AGENCY, AIR QUALITY CRITERIA FOR NITROGEN OXIDES 3-1 (1971) and MIDWEST RESEARCH INSTITUTE, 1 PARTICULATE POLLUTANT SYSTEMS STUDY at Tables 4.1-1 and 4.1-2 (1971).

TABLE 4

NATURAL PRODUCTION

| Input | Output |
|---|---|
| 1. Environmental damages (including those naturally generated)<br>a. Air<br>b. Water<br>c. Land | 2. Environmental services<br><br>3. Net environmental effect |
| NATURAL SECTOR INPUT | NATURAL SECTOR OUTPUT |

reasons. Available estimates of damages due to air and water pollutants cannot distinguish between damages from pollutants that have a human origin and damages from those with a natural origin. Rather than attribute all the damage to nonnatural causes, it is more accurate to prorate the total damage between the two sources.

*Consolidated Gross Product Account*

The above accounts can be consolidated into a modified gross product account, as in Table 5. Inspection of this account indicates that modified GNP equals conventional GNP minus environmental damage. Actually this relationship is an identity: it is necessarily true because of the way we chose to arrange the entries into our accounting structure. However, a number of other arrangements are possible, each leading to its own formula relating the conventional GNP to a "modified" GNP.

To show this, the following notations are defined:

$VA$ = charges against conventional GNP
$GNP$ = conventional GNP
$GNP^i$ = modified GNP, definition $i$ ($i$ = 1, 2, 3, and 4)
$ES$ = environmental services
$NEB$ = net environmental benefit
$ED$ = environmental damage

Since the left-hand side and the right-hand side of the consolidated accounts must balance, the following identity holds:

$$VA + NEB - ES = GNP - ED$$

As noted, this identity implies the following "definition" of modified GNP:

$$GNP^1 = GNP - ED \qquad \text{(Definition 1)}$$

TABLE 5

CONSOLIDATED NATIONAL INCOME AND PRODUCT ACCOUNT

| Input | Output |
|---|---|
| 1. Compensation of employees and proprietors (incl. rental income) (1.2 + 2.2 + 3.2) | 14. Personal consumption (1.13.b + 3.9) |
| 2. Profits with inventory valuation and capital consumption adjustment (1.3) | 15. Gross private domestic investment (1.15) |
| a. Profits tax | |
| b. Profits after tax | 16. Exports (1.13.c) |
| c. Inventory valuation and capital consumption adjustment | 17. Imports (–) (1.5 + 2.3 + 3.3) |
| | 18. Governmental goods and services (2.7) |
| 3. Net interest (1.4) | |
| NATIONAL INCOME | |
| 5. Transfer payments (1.6) | |
| 6. Indirect taxes (1.7) | |
| 7. Subsidies (–) (1.8) | |
| 8. Statistical discrepancy | |
| NET NATIONAL PRODUCT | |
| 10. Capital consumption (1.9 + 3.5) | |
| CHARGES AGAINST GROSS NATIONAL PRODUCT | GROSS NATIONAL PRODUCT |
| 12. Environmental services (–) (1.11 + 2.5 + 3.7) | 19. Environmental damages (–) (1.16 + 2.8 + 3.10 + 4.2) |
| a. Air | a. Air |
| b. Water | b. Water |
| c. Land | c. Land |
| 13. Net environmental benefit (5.16–5.9) | |
| CHARGES AGAINST MODIFIED GROSS NATIONAL PRODUCT | MODIFIED GROSS NATIONAL PRODUCT |

However, as noted, accounting arrangements are arbitrary and other arrangements are possible as long as the accounts balance. For example, by adding *ED* and *ES* to both sides and noting that *NEB* = *ES* – *ED*, a new identity can be formed.

$$VA + ES = GNP + ES$$

which leads to a new definition:

$$GNP^2 = GNP + ES \qquad \text{(Definition 2)}$$

Similarly, by adding only $ES$ to both sides and again noting that $NEB = ES - ED$ we can find a third definition of modified GNP:

$$GNP^3 = GNP + NEB \qquad \text{(Definition 3)}$$

Finally, by first adding $ES$ to both sides and then subtracting $NEB$ from both sides, we can find a fourth definition:

$$GNP^4 = GNP \qquad \text{(Definition 4)}$$

Thus modified GNP can be defined alternatively as conventional GNP less damage, conventional GNP plus environmental services, conventional GNP plus net environmental benefit, or simply as equal to conventional GNP. These definitions are by no means equivalent, but they are all *consistent* with the above modified accounting structure. The pros and cons of these alternatives will be discussed in the next section.

Note first, however, that the modified form of the other conventional national account aggregates, net national product (NNP) and national income (NI), can be defined in terms of the modified GNP. For example, since NNP is defined as GNP less capital consumption allowances, modified NNP can be defined as modified GNP less capital consumption allowances. Of course, as suggested earlier, the capital consumption allowances themselves may be modified to take account of the deterioration in environmental capital.

## RELATIONSHIP BETWEEN THE ENVIRONMENT AND THE MODIFIED ACCOUNTS

Relationships between the modified accounts and the environment will be discussed in terms of the modified GNP concepts. Since the fourth definition of modified GNP is exactly the same as conventional GNP, we need only discuss the first three. The relationship between the environment and conventional GNP has already been discussed in this paper.

### *First Adjustment:* $GNP^1 = GNP - ED$

We argued above that the conventional account aggregates do not always respond to changes in environmental quality in a manner that would make these aggregates acceptable indicators of well-being. Gross national product tended to increase with environmental deterioration and efforts to improve the environment would often be re-

flected by reductions in GNP, particularly if these efforts were undertaken by reallocation of business current account inputs or through shifts in investment.

The above definition of modified GNP clearly seems to perform much better as an indicator of well-being. $GNP^1$ appears to move "correctly" with respect to changes in ordinary GNP and to changes in environmental quality. It is perhaps for this reason that Olson recommended this modification of conventional GNP.[15] Yet this first definition covers only part of the environmental relationship. The second definition covers another part.

*Second Adjustment:* $GNP^2 = GNP + ES$

The theoretical analysis behind the suggested modified accounting framework demonstrated that there was a beneficial environmental service associated with any observed environmental damage. This service, being "unpriced" and apparently "free," does not show up directly in conventional GNP.

The second definition accounts directly for this unpriced input. Its use as an index of well-being would have interesting and perhaps controversial implications. For example, the difference in income between a nonindustrialized, "less developed" society located in a tropical climate that generates environmental services in the form of warmth and abundant, freely available food, and an industrialized society located in a cold climate requiring a highly sophisticated agriculture may be far less if income is measured by $GNP^2$, rather than ordinary GNP. (The difference might also be less under the first definition if the industrialized society were also the more polluted.)

However, $GNP^2$ is prone to possible double counting of environmental services consumed by business. While these services may not be accounted for directly, they may be reflected in profits, which are captured by ordinary GNP. For example, a business that can dispose of its wastes in the ocean has a distinct advantage over a competitor that must treat its wastes. The opportunity to use the ocean's disposal service may show up as an increased profit rate for the business. In this example it would be superfluous for the national accountant to add in an amount equaling the value of the ocean service.

One interesting aspect of $GNP^2$ concerns its behavior with respect to pollution control expenditures. As noted, conventional GNP either is unaltered or declines, depending on whether the expenditure is by business, on capital or on current account, and on whether pollution control capital outlays divert capital from more "productive" uses.

15. *See* M. Olson, *supra* note 6, at 245.

On the other hand, assuming full employment, $GNP^2$ will always decline as pollution control expenditures increase. According to the theory behind our framework, pollution control expenditures mean that marketed goods and services are being substituted for environmental services. Thus, since *ES* will decline, $GNP^2$ will also decline.

Some may feel that because of this result, along with the potential for double counting, $GNP^2$ is a less desirable indicator of well-being than $GNP^1$. However, its focus on the benefits of ES is a strong point in its favor.

*Third Adjustment:* $GNP^3 = GNP + NEB$

Because NEP = ES – ED, this definition of modified GNP appears to be a compromise between $GNP^1$ and $GNP^2$. As an indicator of well-being it appears to move in the "correct" direction: increases in *ES* and decreases in *ED* imply increases in $GNP^3$. However, there are some circumstances under which $GNP^3$ has difficulty in moving in *any* direction. In the absence of technological change, decreases in environmental damage by business, *ED,* must be invariably accompanied by decreases in environmental services to business, *ES.* Thus, under policies of pollution control, *NEB* may remain essentially unchanged. For this reason, $GNP^3$ may not be very effective as an indicator of well-being after all.

## IMPLEMENTATION OF THE FRAMEWORK

Efforts to design and implement the modified accounting framework have been under way for several years under National Science Foundation sponsorship.[16] This section describes these efforts and presents some crude estimates for the years 1972 and 1978.

This research has had to rely primarily on secondary sources of data assembled largely to support policy needs. As a result, the only type of environmental service for which national estimates of value are available is the disposal service provided by the air and water. Damage estimates are consequently confined to that resulting from the air and water pollution associated with the use of these disposal services. Also, many services of the environment are not captured in the available data on *ES.* Aesthetic and recreational services are two examples, although damage to aesthetics and recreation caused by waste disposal are supposedly accounted for in the estimates of *ED.* In addition, not all disposal services are accounted for, nor are all the pos-

16. *See* H. Peskin, *Accounting for the Environment,* 2 SOC. INDICATORS RESEARCH 191 (Sept. 1975) for a description of the research.

sible damages that are related to disposal. For example, the data do not cover the possible carcinogenic effects that may result from the disposal of dangerous chemicals in air or water.

The estimates of environmental damage are drawn from a number of studies of national air and water pollution damage sponsored by the Environmental Protection Agency. These studies have been critically reviewed by Freeman and we will not comment on them here.[17] Suffice it to say that they are generally extrapolations of smaller scale studies of air or water pollution damage in particular locations. There is no assurance that these studies were consistent in their estimation techniques or even in the time period covered. More important, there is no assurance that they used estimation techniques that yield good approximations of the true value to affected parties of eliminating the pollution. Thus the damage estimates are very rough and perhaps either too high or too low by a factor of two or three.[18]

There have been no national studies on the value of environmental disposal services. However, a proxy value of these services to polluters can be obtained by determining the prospective costs these polluters would incur if they were denied access to the disposal service.[19] These prospective costs, in turn, can be estimated by the expected control costs of reducing discharges to a very low level. Unfortunately, actual estimates used often represent the costs of applying specific suggested technologies and application of such technologies may not be the least-cost approach for all firms.[20]

In addition, it is difficult to estimate what the costs would be for an entire industry to adopt a specific control technology. Since the costs have yet to be incurred, they must be based on a mixture of engineering considerations and the experience of firms that have adopted similar technologies in the past. For all these reasons, the cost estimates are only crude approximations to the true value of environmental services to polluters.

The 1972 ES values for water were developed from the cost data by Gianessi and Peskin.[21] The ES values for air come from EPA's *The*

17. A. Freeman, The Benefits of Air and Water Pollution Control: A Review and Synthesis of Recent Estimates (December 1979) (report prepared for the U.S. Council on Environmental Quality, Washington, D.C.).

18. This estimate is based on the ranges given by Freeman. *Id.* at xiii-xv.

19. Note that these costs are not the same as the costs actually experienced as a result of pollution abatement efforts. These costs are already captured in the conventional accounts although they have only recently been separately identified by the Bureau of Economic Analysis in their Pollution Abatement Expenditures series. *See* F. Segel & F. Dreiling, *Pollution Abatement and Control Expenditures, 1972-6*, 58 SURVEY OF CURRENT BUS. 12 (Feb. 1978).

20. The technologies are suggested as guidelines for permit writers.

21. L. Gianessi and H. Peskin, *The Distribution of the Costs of Federal Water Control Policy*, 56 LAND ECON. 83 (Feb. 1980).

*Economics of Clean Air (1972)*[22] and Gianessi, Peskin, and Wolff.[23] For 1978, the 1972 values were increased to allow for economic growth and decreased to allow for the reduction in environmental disposal services as a result of the implementation of the 1970 Clean Air Act and the 1972 Federal Water Pollution Control Act Amendments. The degree of implementation is estimated as above by taking the ratio of reported pollution abatement capital outlays to Resources for the Future's estimates of required capital outlays.

All the ES and ED estimates are in units of dollars per year. Therefore, all investment cost estimates have been converted to an equivalent annualized form.[24] The modified accounts with the estimates are shown in Tables 6 and 7. All estimates are in current dollars.

According to these data, the level of environmental services or damages is rather small compared with major components of GNP such as personal consumption or gross private domestic investment. While in current dollars ES and ED are about the same in 1972 and 1978, there is clearly a decline in the value of both variables in 1978 if the effects of inflation are taken into account.

One of the biggest differences between 1972 and 1978 is in the balance between the use of environmental disposal services by a particular sector and the damages caused by that sector. Thus, in 1972, industry generated about twice as much damage to the air as it received in services from the air. On the other hand, households received disposal services from the air three times larger than the damages they caused (mostly due to automobile pollution). There was a much closer balance between damages and services for both industries and households in 1978.

It is apparent that, by any of the alternative definitions, the differences between conventional GNP and modified GNP are relatively small. The fact that the adjustments due to inclusion of the environment are small is not without significance and does perhaps help put the "environmental problem" in perspective. However, it should be kept in mind that *ES* reflects only disposal services. It may have been very much larger if other environmental services—such as recreation and aesthetic services—were included. Further research and data development will be required before comprehensive estimates of these other services can be made.[25]

22. U.S. ENVT'L PROTECTION AGENCY, THE ECONOMICS OF CLEAN AIR: ANNUAL REPORT OF THE ADMINISTRATOR (1972).

23. L. Gianessi, H. Peskin, & E. Wolff, *The Distributional Effects of Uniform Air Pollution Policy in the United States*, 93 Q. J. ECON. 281 (May 1979).

24. This conversion was done using a capital recovery factor formula as described in E. GRANT & W. IRESON, PRINCIPLES OF ENGINEERING ECONOMY (1960).

25. Presently, the National Science Foundation is sponsoring a Resources for the Future research project along these lines.

TABLE 6

1972 CONSOLIDATED NATIONAL INCOME AND PRODUCT ACCOUNT
(billions of 1972 dollars)

| Input | | | Output | |
|---|---|---|---|---|
| 1. Compensation of employees and proprietors (incl. rental income) | | 812.8 | 14. Personal consumption | 733.0 |
| 2. Profits with inventory valuation and capital consumption adjustment | | 92.0 | 15. Gross private domestic investment | 188.3 |
| a. Profits tax | 41.5 | | 16. Exports | 72.7 |
| b. Profits after tax | 54.6 | | 17. Imports (–) | 75.9 |
| c. Inventory valuation & capital consumption adjustment | –4.1 | | 18. Governmental goods and services | 253.1 |
| 3. Net interest | | 47.0 | | |
| NATIONAL INCOME | | 951.8 | | |
| 5. Transfer payments | | 4.7 | | |
| 6. Indirect taxes | | 111.0 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7. Subsidies (–) | | | 3.6 | | | | |
| 8. Statistical discrepancy | | | 1.7 | | | | |
| NET NATIONAL PRODUCT | | | | 1065.6 | | | |
| 10. Capital consumption | | | 105.4 | | | | |
| CHARGES AGAINST GROSS NATIONAL PRODUCT | | | | 1171.0 | GROSS NATIONAL PRODUCT | | 1171.0 |
| 12. Environmental services (–) | | | 45.9 | | 19. Environmental damages (–) | | 30.0 |
| a. Air, To: | | 23.8 | | | a. Air, By: | 21.9 | |
| 1. Industry | 8.4 | | | | 1. Industry | 16.3 | |
| 2. Households | 12.9 | | | | 2. Households | 4.3 | |
| 3. Governments | 2.5 | | | | 3. Governments | .2 | |
| 4. National | NA | | | | 4. National | 1.1 | |
| b. Water, To: | | 22.1 | | | b. Water | 8.1 | |
| 1. Industry | 21.4 | | | | | | |
| 2. Households | .6 | | | | | | |
| 3. Government | .1 | | | | | | |
| 4. Natural | NA | | | | | | |
| c. Land | | NA | | | c. Land | NA | |
| 13. Net environmental benefit | | 15.9 | | | | | |
| MODIFIED CHARGES AGAINST GROSS NATIONAL PRODUCT | | | | 1141.0 | MODIFIED GROSS NATIONAL PRODUCT | | 1141.0 |

TABLE 7

1978 CONSOLIDATED NATIONAL INCOME AND PRODUCT ACCOUNT
(billions of 1978 dollars)

| Input | | | | Output | |
|---|---|---|---|---|---|
| 1. Compensation of employees and proprietors (incl. rental income) | | 1447.2 | | 14. Personal consumption | 1350.8 |
| 2. Profits with inventory valuation and capital consumption adjustment | | 167.7 | | 15. Gross private domestic investment | 351.5 |
| a. Profits tax | 84.5 | | | 16. Exports | 207.2 |
| b. Profits after tax | 121.5 | | | 17. Imports (–) | 217.5 |
| c. Inventory valuation & capital consumption adjustment | –38.3 | | | 18. Governmental goods and services | 435.6 |
| 3. Net interest | | 109.5 | | | |
| NATIONAL INCOME | | | 1724.3 | | |
| 5. Transfer payments | | 9.2 | | | |
| 6. Indirect taxes | | 178.1 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7. Subsidies (–) | | | 4.2 | | | | |
| 8. Statistical discrepancy | | | 3.3 | | | | |
| NET NATIONAL PRODUCT | | | | 1910.7 | | | |
| 10. Capital consumption | | | 216.9 | | | | |
| CHARGES AGAINST GROSS NATIONAL PRODUCT | | | | 2127.6 | GROSS NATIONAL PRODUCT | | 2127.6 |
| 12. Environmental services (–) | | | 45.1 | | 19. Environmental damages (–) | | 31.0 |
| a. Air, To: | | 20.1 | | | a. Air, By: | 18.2 | |
| 1. Industry | 7.1 | | | | 1. Industry | 9.3 | |
| 2. Households | 10.9 | | | | 2. Households | 6.9 | |
| 3. Governments | 2.1 | | | | 3. Governments | .3 | |
| 4. National | NA | | | | 4. National | 1.7 | |
| b. Water, To: | | 25.0 | | | b. Water | 12.8 | |
| 1. Industry | 24.4 | | | | | | |
| 2. Households | .5 | | | | | | |
| 3. Governments | .1 | | | | | | |
| 4. Natural | NA | | | | | | |
| c. Land | | NA | | | c. Land | NA | |
| 13. Net environmental benefit | | 14.1 | | | | | |
| MODIFIED CHARGES AGAINST GROSS NATIONAL PRODUCT | | | | 2096.6 | MODIFIED GROSS NATIONAL PRODUCT | | 2096.6 |

Comparisons of the four modified GNP concepts are shown in Table 8. $GNP^4$, which is equivalent to unmodified GNP, increased about 19 percent between 1972 and 1978 (constant dollars). $GNP^1$, which is smaller than unmodified GNP because of the subtraction of *ED*, had a growth rate about two percentage points higher, reflecting the beneficial effects of 1970 and 1972 pollution control legislation. Both $GNP^2$ and $GNP^3$, which are slightly larger than ordinary GNP, grew at a somewhat lower rate, although these two might have grown more if a more comprehensive measure of environmental services were available.

These movements in the various GNP concepts reflect movements in *ES*, *ED*, and *NEB*. Net environmental benefit is positive in both years, indicating that the value of disposal services exceeded the damages caused by the disposal. However, there was a substantial decline in *NEB* by 1978 because the disposal service value of the environment declined more rapidly than damages. This pattern should continue for future years since the prospective costs per unit of reduced damage, which are used as proxies for the value of environmental disposal services, are likely to rise as damages are reduced.

TABLE 8

COMPARISON OF MODIFIED GNP CONCEPTS AND ASSOCIATED ENVIRONMENTAL BENEFITS

| | 1972 (billions of current dollars) | 1972 (billions of constant dollars) | 1978 (billions of current dollars) | 1978 (billions of constant dollars) | Change in 1972 to 1978 (billions of constant dollars) | % Change in 1972 to 1978 |
|---|---|---|---|---|---|---|
| ES | 45.9 | 45.9 | 45.1 | 27.1 | −18.8 | −41 |
| ED | 30.0 | 30.0 | 31.0 | 20.5 | −9.5 | −32 |
| NEB | 15.9 | 15.9 | 14.1 | 6.6 | −9.3 | −58 |
| $GNP^1$ | 1141.0 | 1141.0 | 2096.6 | 1378.7 | 237.7 | 21 |
| $GNP^2$ | 1216.9 | 1216.9 | 2172.7 | 1426.3 | 209.4 | 17 |
| $GNP^3$ | 1186.9 | 1186.9 | 2141.7 | 1405.8 | 218.9 | 18 |
| $GNP^4$ | 1171.0 | 1171.0 | 2127.6 | 1399.2 | 228.2 | 19 |

It would be incorrect to draw too many conclusions from these data in view of the crudeness of the *ES* and *ED* estimates. Clearly, there is a lot of room for improvement in these estimates. Methods for obtaining better measures of environmental damage and control costs can be found in the extensive literature on cost-benefit analy-

sis.[26] While environmental benefits due to policy are not the same thing as environmental damages due to the absence of policy, the techniques for estimating benefits can be used to estimate damages. Since much of this literature is already available, methods of improving benefit and cost estimates will not be discussed here.

## SHOULD GNP BE MODIFIED?

The above estimates of potential modifications to GNP are extremely rough, reflecting the difficulties of imputing values to environmental services and damages. The most obvious deficiency of this attempt to adjust GNP is the inability to take account of the full range of services provided by the environment. While some adjustments for air and water pollution damage and their control can be made, other environmental adjustments are impossible to make with current data. They might significantly affect GNP.

These facts alone, however, do not argue against efforts to modify the conventional national economic accounts along the lines suggested. Since the new account entries in no way destroy the existing accounting system, they could be either accepted or ignored, depending on how one felt about the worthiness of imperfect estimates. Nevertheless, even modest efforts to develop and improve such data will be expensive. Thus it is reasonable to ask whether the effort is worth it.

The answer to this question depends, not only on the actual and perceived value of the new information and new GNP concepts that may emerge from the effort, but also on the perceived value of the current GNP and national accounting efforts. The reason for this latter dependence is that the new effort may divert scarce resources that go into the conventional accounts. It may also divert some of the attention the conventional accounts and, especially, GNP receives in the popular press.

Of course, those dissatisfied with the conventional GNP may welcome such diversions. But in all fairness, it must be recognized that the existing system serves important analytical and policy purposes. The national accounts, after all, have provided the basic data and indexes for describing economic activity and developing economic policy for nearly 50 years. Defenders of the existing national economic

26. *See, e.g.*, H. PESKIN & E. SESKIN, COST-BENEFIT ANALYSIS AND WATER POLLUTION POLICY (1975) and A. Freeman, *supra* note 17.

These references contain extensive bibliographies on the application of cost-benefit analysis to environmental problems.

accounts do not base their arguments on a mistaken belief that the GNP measures well-being, but rather on the position that any modifications may impair its analytical and policy usefulness. While they may see a need for better information on environmental and other factors that affect well-being, they argue that such data can be and should be collected independently of the national accounting system.[27]

There are two principal objections to this line of argument. In the first place, it assumes that the national accounts are adequate for economic analysis and policy. While the accounts may be adequate for traditional economic concerns–production, employment, inflation–that are reflected in the marketplace, in recent years there have been new economic concerns–the allocation of time in the household, development of human capital, management of environmental resources–that are only imperfectly reflected in the marketplace. Those who think these issues are important are not likely to find it of overriding importance to maintain the integrity of the existing accounting system.

The other objection is that any effort to develop independent data sets on items ignored by the conventional accounts is likely to be chronically underfunded and generally ignored as long as the conventional GNP and the national accounting activities maintain an official and singular status in the federal bureaucracy. Given this status, it is not surprising that the public places more importance on the GNP as a measure of well-being than do the experts.

Moreover, there are close interdependencies between market and nonmarket activities. Use of the environment, for example, is affected by a host of economic decisions by producers and consumers: the entrepreneur's choice of a production process, the consumer's decision to watch television or go fishing. An expanded national accounting system, rather than a set of independent data series, would reveal and permit easier analysis of these interdependencies. Also (and this is especially true for environmental data), much of the data in the conventional accounts and the additional data needed to expand the accounts and develop new GNP measures come from the same basic sources (e.g., the Census of Manufacturers) as the data now collected.

None of these arguments can be dismissed out of hand. While it does appear worthwhile to explore new methods of expanding the conventional GNP concepts, and while, for reasons of public visibility and efficient data collection, such efforts are probably best coordi-

27. *See, e.g.*, E. Denison, *Explanation of Declining Productivity Growth*, 59 SURVEY OF CURRENT BUS. 1 (Aug. 1979).

nated by the same federal bureaucracies that are responsible for the conventional accounts,[28] it would be unfortunate if they led to a weakening of the present national accounting method.

Any attempt to construct a better GNP will require new sources of funds. Costs can be kept down through the use of data already collected by various federal agencies, usually for their own administrative purposes. For example, estimates of environmental disposal services can be drawn from data currently being assembled as part of the rulemaking procedures of the Environmental Protection Agency. Also buried in various environmental impact statements is material that could be used to develop information on environmental damage.

With good planning and coordination, it should be possible to modify slightly the form by which data are collected and stored by the various administrative agencies so that they can more easily be incorporated into an expanded national accounting structure. It may be worthwhile for the heads of such agencies as the Environmental Protection Agency, the departments of Interior, Commerce, and Agriculture, and the Council on Environmental Quality to convene a committee for this purpose. It would be unfortunate if efforts to find better GNP measures were thwarted by a false belief that the costs of the effort are "too high"—a perception that overlooks the benefits of good interagency cooperation.

28. For this reason, it is unfortunate that the Bureau of Economic Analysis, the agency responsible for the national accounts, is terminating its recently established programs to conduct research on accounting for nonmarket activities.