Sustainable National Income (SNI)

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1 Introduction

SNI assesses the distance between the present and the sustainable level of production and consumption. SNI represents the maximum level of economic activity that can be developed within an accounting period that respects the sustainability standards. All the costs that need to be made to meet the standards of pollution and resource use in order to prevent the sustainability standards to be exceeded, irrespective whether they are to be made by industry, government or households, are considered to be intermediary expenditures and should therefore not count as income. To put it simply, SNI is the difference between standard national income and the expenditures that need to be made to respect the sustainability standards.

In Hueting's approach to sustainable income accounting, a sharp distinction is made between objectively determinable sustainability and the sustainable use of environmental functions on the one hand, and society's subjective preferences for such a use on the other hand. Environmental functions can be defined as the set of possible uses of the biophysical environment. If the use of one function is at the expense of other functions or of its own future use, the function is scarce, i.e., its use entails an opportunity cost—a "price" (Hueting, 1974). Sustainability requires such use of environmental functions as to assure their indefinite availability. Note that this definition of sustainability does not necessarily require the conservation of all environmental assets. If an environmental function can be performed by several environmental assets, substitution between these assets is allowed in principle. For example, the function "resources for energy production" can be performed by fossil energy resources such as coal, oil and gas, but also by renewable energy resources such as solar, wind, and hydro. For a sustainable use of the function "resources for energy production" the depletion of the stock of one kind of asset (e.g., oil) is no problem as long as its depletion is accompanied by an equivalent increase in the stock of substitute assets (e.g., solar).

Is sustainability, i.e., the sustainable use of environmental functions, desirable? Does society want to preserve all environmental functions indefinitely *at all costs*? The answer to these questions can only be given on the basis of society's subjective preferences for the use of environmental functions. Hueting stresses the point that, in general, society's subjective preferences for environmental functions and therefore its "demand" for these functions is not (completely) observable. It is difficult to derive individual preferences for environmental functions based on observed behaviour. There are no markets for environmental functions. Although some information on the demand for environmental functions can be inferred from defensive expenditure and financial damage, this information is incomplete and often does not address the most vital functions such as the

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functions of the life-support systems of our planet. Alternative valuation techniques such as contingent valuation are not very accurate and are not always applicable. Moreover, none of these techniques can provide reliable data on society's preferences for a liveable environment for future generations. In a word, whether or not we want to become "sustainable" is not known. Hueting therefore makes assumptions on preferences. He strictly separates the "objective" concept of sustainability (the indefinite availability of environmental functions) from the question whether or not society really wants to achieve such sustainability (Hueting and Reijnders, 1998).

2 Methodology

Given the lack of knowledge of subjective preferences, SNI shows the correct measure of national income only if one *assumes* that society's preferences for the sustainable use of the environment are absolute, i.e., independent of their costs. Hueting argues that there are as many green national incomes as there are assumptions on subjective preferences for environmental services. These subjective preferences include preferences for future availability of environmental functions, thus affecting the discount rate at which future benefits and costs are assessed. This situation will persist as long as we are unable to correctly measure subjective preferences for the current and future use of environmental functions. In this unfortunate situation it is necessary to be explicit about one's assumptions. Sustainable National Income represents the maximum level of income that can be derived from thát level and composition of economic activity that leaves environmental functions available, now and in the future, given the state of technology in the year of reporting. Whether Sustainable National Income, thus defined, correctly measures welfare or utility is another question altogether. An important assumption is that society's preference for the sustainable use of environmental functions is absolute, i.e., independent of the cost of achieving this sustainable use. Hueting stresses the point that this assumption cannot be accepted or refuted on empirical grounds. Another important issue regards the role of future technological improvement in the efficiency of use of environmental resources. Hueting, deliberately, does not take this factor into account. He acknowledges that such future technological improvement could in principle lessen the tension between economic growth and environmental degradation, but he does not want to speculate on it. In fact, he is sceptical on the chances that as yet not implemented an unknown technology can safeguard the environment for future generations in the face of ever-increasing population and production (Hueting, 1996). SNI assesses the *distance* between the present and the sustainable level of production and consumption, given today's technology. When the calculation of SNI is repeated in later years it can be assessed whether technological improvement has indeed reduced this distance.

Hueting further assumes that conditions for the sustainable use of environmental functions can be determined by science and can be expressed in the form of physical standards. The sustainability standards should be in the form of "no more pollution should be allowed than can be naturally assimilated by the environment", or "so many fish may be caught that the catch is maximal but sustainable" and consequently does not deplete the stock (Hueting and Reijnders, 1998). SNI is directly dependent on the sustainability standards. When there is large scientific uncertainty on the maximum sustainable use of environmental resources, there will be a corresponding uncertainty in the estimated SNI.

SNI assesses the maximum level of economic activity that can be developed within an accounting period that respects the sustainability standards. The diagram in Figure 1 illustrates this idea in a simplified way.

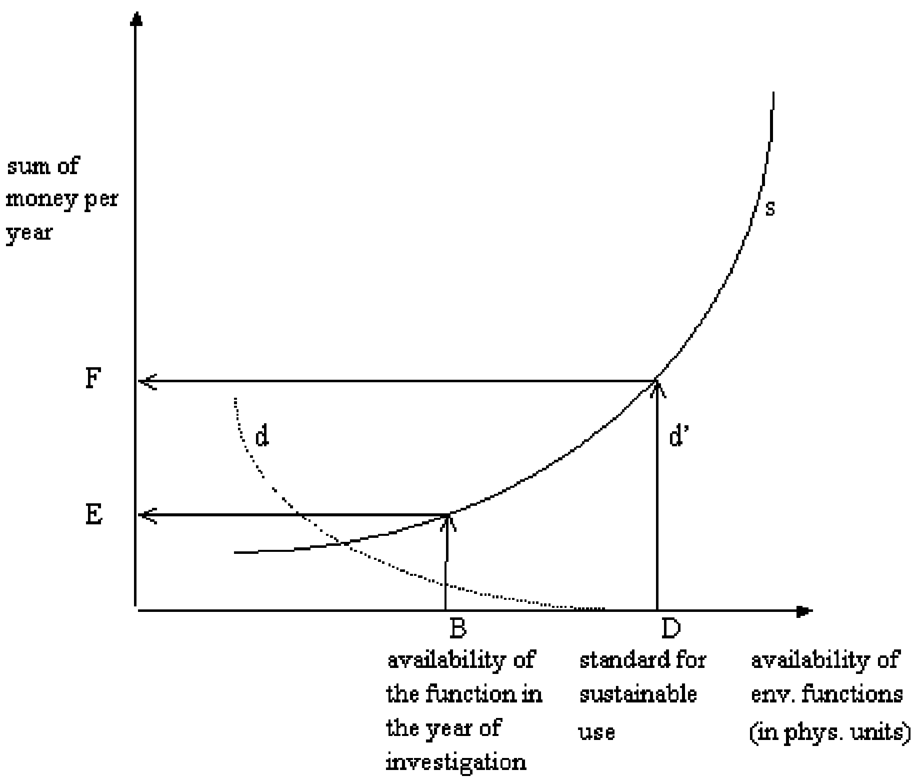

Figure 1 Demand and supply of environmental functions. Source: Hueting et al. (1995).
s = supply curve or elimination cost curve
d = incomplete demand curve based on individual preferences (revealed from expenditures on compensation of functions and on restoration of physical damage);
d' = approximate demand curve based on assumed preferences for sustainability;
BD = distance that must be bridged in order to arrive at sustainable use of environmental functions;
EF = costs of the loss functions, expressed in money.

The X-axis depicts the level of an environmental function, e.g., the cleanness of air, the integrity and size of natural habitats, the stock of fish in the sea, all expressed in physical dimensions. The Y-axis depicts money. Curve s is the supply curve for the environmental function or the elimination cost function. It shows the costs of sustaining a certain level of the environmental function. The part of the social demand curve for the environmental function that can be observed is d. This curve is based on individual preferences revealed from expenditures on compensation of functions and resoration of physical damages and is obviously incomplete. Hueting et al. (1995) argue that a complete demand curve for environmental functions, based on individual preferences, cannot be determined. Many governments, however, including the Dutch, have adopted 'sustainable development' as official government policy. If this is taken seriously, one may assume that society has collectively expressed an absolute preference for the preservation of (certain) environmental functions. This absolute preference is depicted in the *assumed* 'collective' demand curve d'. Demand for an environmental function is then equal to the sustainability standard, and it is completely inelastic. Now assume that the present level of the environmental function on the X-axis is B. To reach the sustainable level at D, elimination costs of the magnitude of EF have to be made. If this exercise is repeated for all environmental functions that have to be sustained, then the sum of all EF's is the money-difference between the standard national income and the SNI.

In the SNI approach cost-effectiveness or elimination cost curves play a central role. A cost-effectiveness curve indicates the relationship between the level of an environmental function and the social costs that are needed to restore and maintain this level. In the SNI methodology costs can accrue from two different sets of actions. The first set of actions comprise technical measures to reduce pollution from a given economic activity. These technical measures can be 'end of pipe' measures, process changes, or the development of alternatives for non-renewable resources. Abatement cost functions for the depletion of fossil fuels, climate change, depletion of the ozone layer, acidification, VOCs, eutrophication, zinc emissions, photochemical ozone, aridification, and local soil pollution have been estimated (Dellink et al., 1997). The second set of actions comprise volume reductions in the burdening or extracting economic activities themselves, under the condition of constant employment. In a macro-economic or general equilibrium framework such volume reductions would amount to structural shifts in the sectoral composition of an economy - that is a shift away from environment burdening towards less-burdening activities.

The measures from one or more of these sets of actions will typically affect more than one sector of the economy, and possibly all. The effects of the implementation of technical measures and sectoral shifts on the level of national income should therefore preferably be evaluated in an integrated multi-sector framework (Hueting and De Boer, 2001; Zeelenberg et al., 1997).

Gerlagh et al. (2002) built an applied general equilibrium model for the Netherlands with elimination cost curves and sustainability standards for various environmental themes by which such an integrated assessment could be carried out.

3 Process

The SNI is computed by an applied general equilibrium model (the SNI-AGE model) in which the 'sustainability standards' act as restrictions on the feasible set of solutions. The model contains detailed abatement cost curves for environmental themes. The difference or "gap" between SNI and conventional NNI measures the dependence of the economy on that part of its natural resource use that exceeds the sustainable exploitation levels. The gap between SNI and NNI is therefore an indicator of the extent of unsustainability of an economy

To compute the SNI, one needs the SNI computer model with a set of environmental restrictions and abatement cost curves, a dataset with economic and environmental (NAMEA) data for a particular country and year, a set of sustainability standards.

4 Review

4.1 Evaluation results

The SNI method gives an *ex-post* assessment of the economic performance of an economy over a time period of a year. Aspects of sustainable development that are included are economic performance and environmental damage and resource depletion. It calculates the hypothetical national income that would have been achieved if the economy had respected the sustainability standards.

The sustainability standards presently incorporated in the SNI-AGE model refer to nine environmental themes (see Table 1). For sustainability – it is assumed – individual environmental pressures should be reduced by a range from 46 percent (fine particles in air) to 100 percent (dehydration, soil contamination). The SNI model contains detailed information on abatement technology for each environmental pressure with respect to effectiveness as well as costs. There are, however, limits to the extent to which abatement technology can be employed cost-effectively. For example, to meet the sustainability standard for the greenhouse effect, about 45% of the required reduction can be achieved through technical measures in various sectors of the economy, while the remainder should be reduced through changes in the size and composition of the economy (Gerlagh et al., 2002).

Table 1 Sustainability standards for the Netherlands, 1990

Environmental theme	Unit	Base 1990	Sustainability standard	Reduction (%)
Greenhouse effect	bln kg CO_2-eq.	251	53	79%
Ozone depletion	mln kg CFC11-eq.	10.4	0.5	94%
Acidification	bln Acid eq.	38.4	10.0	74%
Eutrophication	mln kg P eq.	312	128	59%
Fine particles in air	mln kg PM10	440	240	46%
Smog formation	mln kg NMVOS	44	20	55%
Dispersion to water	bln AETP eq	194	73	62%
Dehydration	% affected area	100	0	100%
Soil contamination	# contaminated sites	600,000	0	100%

Source: Gerlagh et al., 2002.

SNI-AGE can also calculate the consequences to sustainable national income of alternative economic scenarios. It is therefore able to be of use for prospective, *ex-ante*, assessments of the sustainability impacts of economic developments.

4.2 Experiences

Sustainable National Income for the Netherlands has been calculated for 1990, 1995 and 2000 (Gerlagh et al., 2002; Hofkes et al., 2004). The calculations show that sustainable national income would be about 56 percent below conventional national income (NNI) in the year 1990. The reduction of greenhouse gases is responsible for the bulk of the income loss. The trend analysis of Hofkes et al. (2004) shows that the relative gap between NNI and SNI has decreased in the Netherlands over the period 1990 to 2000, but that the absolute gap over the same period has increased by 13 billion Euro. Hofkes et al. (2004) decompose the changes in SNI over the period 1990-2000 in scale, composition and technique effects. The technique effect (the emission intensities of economic activities) has contributed most to the relative increase in SNI over that period and prevented a further increase of the absolute gap between NNI and SNI.

4.3 Combinations

The SNI-AGE model makes use of NAMEA data, abatement cost curves, and sustainability standards.

4.4 Strengths and weaknesses

The main strengths of the SNI method are its clear and comprehensive measure of sustainability that is not dependent upon estimates of subjective preferences for environmental quality, and its robust general equilibrium methodology that takes account of all interdependencies and feedbacks between one the one hand the economy and the environment and on the other hand between various alternative environmental themes.

The SNI-AGE model is complex and needs highly skilled personnel to operate and maintain it. The formulation of the sustainability standards is difficult, but once obtained, several standards may be transposed to other countries. For the general public, the methodology (the applied general equilibrium model) may be difficult to understand.

4.5 Further work

It would be interesting to test the SNI-AGE model for other countries inside and outside the EU. Another interesting direction would be to use SNI-AGE for an *ex-ante* assessment of alternative socio-economic development paths.

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