The Tinbergen Hueting Approach in the Economics of Ecological Survival

Colignatus, Thomas

Samuel van Houten Genootschap

9 March 2009

DRAFT

The Tinbergen & Hueting Approach in the Economics of Ecological Survival

Thomas Colignatus

Samuel van Houten Genootschap

1st edition, March ? 2009

Supported by

Samuel van Houten Genootschap
Wetenschappelijk bureau van het Sociaal Liberaal Forum
Scientific bureau of the Social Liberal Forum
http://www.dataweb.nl/~cool/SvHG/SvHG.html

Published by

ISBN 90-

JEL A00

Nederlandse uniforme genre indeling (NUGI) 681, 654 & 691

CIP-GEGEVENS KONINKLIJKE BIBLIOTHEEK ‘S-GRAVENHAGE

Contents in Brief

Introduction **7**

Roefie Hueting and Sustainable National Income **11**

The choice on sustainability: information or the meta-SWF approach to a shift of preferences **14**

The Old Man and the SNI. A review of advance and adversity in Hueting's research in economic growth and the new scarcity from the environment and sustainable national income (SNI) **21**

The seminal contribution of Roefie Hueting to economic science: Theory and measurement of (environmentally) Sustainable National Income **57**

On the political economy of environmental survival versus collapse. Clarifying the work done by Tinbergen & Hueting vis-à-vis Weitzman, Nordhaus and Stern **66**

"Genuine Savings" at the World Bank **88**

Reaction to Bjørn Lomborg **92**

Conclusions of this book **97**

Appendices **98**

I thank Roefie Hueting, Bart de Boer and Thea Sigmond for their comments over some years now. All errors remain mine.

Contents

Introduction **7**
The economics of ecological survival 7
The Tinbergen & Hueting approach 7
The contents of this book 8
Limitations of this study 9
Caveat 10

Roefie Hueting and Sustainable National Income **11**
National accounts 11
Environmental functions 11
Demand and supply 12
Two questions 12
Revolution in statistics 13
Conclusion 13

The choice on sustainability: information or the meta-SWF approach to a shift of preferences **14**
Introduction 14
The environmental issue 14
Basic concepts 15
Model 16
Graphs 17
Tables 17
Closer understanding 19
Conclusion 20
Appendix: Program 20

The Old Man and the SNI. A review of advance and adversity in Hueting's research in economic growth and the new scarcity from the environment and sustainable national income (SNI) **21**
1. Introduction 22
1.1 A topic in political economy 22
1.2 Making a compass for economic policy on the environment 24
1.3 A guiding diagram 25
1.4 National accounting 27
1.5 A guiding table 30
1.6 A summary deduction 31
2. The period up to "New Scarcity and Economic Growth" 1974 33
3. Some conclusions from "New Scarcity and Economic Growth" 1974 34
4. Reception of "New Scarcity and Economic Growth" 35
4.1 On the positive side 35
4.2 Six year delay in the publication of the English translation 35
4.3 No adoption of the key proposal 36
5. The period up to the Brundtland report 1987 37
5.1 SNI and eSNI 37
5.2 The notion of (environmentally) Sustainable National Income (eSNI) 37

5.3 Hueting on the Brundtland report 38
6. The period up to the Hueting Congress 1999 38
6.1 Tinbergen & Hueting 1991 38
6.2 CBS and CPB 38
6.3 Inside CBS Statistics Netherlands 1991-1999 40
6.4 eSNI and ecological economics 48
6.5 The Hueting Congress 1999 51
7. The period up to 2008 51
7.1 Retirement 51
7.2 Dutch eSNI trend 1990-2000 52
7.3 The Stern Review 2006 52
7.4 A missed chance for Germany and Eurostat 53
7.5 A mysterious disappearance of a crucial subsidy 53
8. Concluding remarks 54

The seminal contribution of Roefie Hueting to economic science: Theory and measurement of (environmentally) Sustainable National Income 57
Introduction 57
Setting 58
Hueting's contribution 60
Concluding remarks 63
Appendix: Cost of calculating eSNI 64

On the political economy of environmental survival versus collapse. Clarifying the work done by Tinbergen & Hueting vis-à-vis Weitzman, Nordhaus and Stern 66
Introduction 66
The two approaches 67
Rightly scaring people 69
Possibly entertaining people 72
Definitions of uncertainty and risk 72
A fat tail is not needed to get scared 73
Facts, of the past and of reality 74
Scenario analysis and cost-benefit analysis 75
The Sterner & Persson approach 76
A small note on calculating the damage 76
Rate of discount 77
Nordhaus and sustainability 77
Conclusion 79
Appendix A. Possibly entertaining people (continued) 80
Appendix B. Nordhaus and sustainability (continued) 81
Appendix C. Nordhaus (2007b) on the role of federal statistical agencies 85

"Genuine Savings" at the World Bank 88
Weak versus strong sustainability 88
Genuine Savings versus eSNI 89
Costs of calculation 91
Conclusion 91

Reaction to Bjørn Lomborg 92
(A) "The skeptical environmentalist", CUP 2001 92
Introduction 92
Three angles 93

Points in more detail 93
(B) “Cool it”, Knopf 2007 96

Conclusions of this book **97**

Appendices **98**
Abstract 98
Literature 99
Index 106

Introduction

The economics of ecological survival

In this book, ecological survival is not an issue of drama but of governance and economics. The warnings by ecologists, and observations that everyone can read or see and hear in the newsmedia, here are not considered by themselves but are only an inspiration to consider economics and preparation of economic policy.

It is relatively easy to emphasize the drama. The world problems with overpopulation and exhaustion of the environment grow bigger by the decade and are drawing the attention of national governments, citizens and researchers alike. Extinction of species takes place at an accelerating rate. Extinction of the human species itself is apparently not at stake though some authors relate that if bees are affected then food will become rather scarce. For this book, we regard all these tales as likely interesting but not our focus of attention. For us, the focus is: if there would be an issue of ecological survival, how would economics deal with it ?

Subsequently, we zoom in on the Tinbergen & Hueting (1991) approach in comparison to other approaches. It is the approach in economics with respect to the measurement of environmental sustainability. When economic policy has a yardstick for environmental sustainability then we can determine which policies cause ecological disaster and which policies steer towards ecological survival.

The Tinbergen & Hueting approach

Tinbergen has been one of the founding fathers of national accounting, alongside with Keynes, Hicks, Kuznets, Meade, Stone and others. Tinbergen (1985) for example shows his awareness of the phenomenon of *counterproduction* – which Hueting nowaday calles "asymmetric entries". [1] Hueting has been writing about environmental economics since the mid 1960s and received early support from Tinbergen. Their joint statement is Tinbergen & Hueting (1991) and this will be our focus.

Since Hueting has been writing most explicitly about environmental economics this book will refer mostly to his separate work and only on occasion to the joint paper Tinbergen & Hueting (1991). Indeed, the development of the definition of *(envrionmentally) sustainable national income* (eSNI) is also Hueting's original contribution to economic

[1] This is best explained with an example. When a car pollutes the air then we can install a catalyst to reproduce the previous clean air. Current methods of the national accounts record that the sale of the catalyst generates a flow of income for who produces that catalyst. In itself this is correct since the change from polluted air to clean air is an improvement. However, the quality of the air has not changed from the original situation. The "counterproduction" by the car has to enter somewhere too. The recorded income from the catalyst is better substracted from the supposed income from making the car.

science. The importance of the Tinbergen & Hueting (1991) paper however is that Tinbergen with his background in national accounting and econometric modelling fully endorses that approach and regards it as a natural extension for his own work and for economics as a whole.

Tinbergen originally helped as well in the determination and selection of the key aims in economic policy: balanced budget, stable prices, full employment, economy growth, a small surplus on the balance of payments to support development assistance, more equal distribution of income. Over the years governments have put different accents and weights on these aims. In The Netherlands economic growth was officially replaced with sustainable economic growth – but the notion of environmental sustainability seems to have got diluted.

The Tinbergen & Hueting approach considers social welfare, focusses on sustainability, and selects national income and economic growth as the main variables for policy makers. The notion of income interacts with the notion of the environment. When environmental functions become scarce, they get a price, as, for example, there are abatement costs. In the current measure of national income these costs are regarded as income. In the proper measure of national income we however should also substract the loss of welfare due to the fact that we have lost the free use of those environmental functions. The Tinbergen & Hueting approach then contrasts the current measurement of "economic growth" with an accompanying mearure of "(environmentally) Sustainable National Income" (eSNI) and its growth.

The contents of this book

This book starts with a short introduction in the work by Hueting which paper originally was published as Colignatus (2001). This provides a basis for my subsequent paper on the meta-SWF (social welfare function) for the choice between standard national income (NI) and (environmentally) sustainable national income (eSNI). The reader should be aware that this presentation is not the one (originally) given by Hueting. However, I think that it provides a useful introduction into the issues involved in a format that economists will generally understand. Hueting's position is that it is unclear to what choice that meta-SWF would lead since the preferences are unknown. My suggestion however is that Hueting's argument is better understood when it is clarified that a choice must be made – which is the concept of that meta-SWF.

In the Summer of 2001 Bjørn Lomborg published his book *The skeptical environmentalist*, as an update of an earlier Danish version. Unfortunately, he does not refer to Hueting's work. Lomborg relies on the argument that national income has to grow before one is rich enough to care for the environment - but this is precisely the fallacy that Hueting warns for. Lomborg, originally trained as a political scientist, takes here the position of a statistician like Hueting, and his book has many good qualities. So we may hope that the meeting of minds of these statisticians will produce a beneficial result. Of course, below we will also meet the film *An inconvenient truth* by Gore et al. (2006), the UK Stern Review (2006) and Lomborg (2007) "Cool it!" in a reprise, which clarifies that this meeting of minds hasn't occurred yet.

The paper *The Old Man and the SNI* relates of the advance and adversity in Hueting's research over the years. By linking to the actual path of creation the reader will gradually grasp in a bottom-up manner on what is achieved in terms of content. The converse top-down manner is used in the subsequent paper on the seminal contribution. All this

provides a sound basis for the paper that compares the approaches by Tinbergen & Hueting vis-à-vis Weitzman, Nordhaus and Stern.

Limitations of this study

My perspective on this topic is rather limited. Five aspects can be mentioned.

(i) I am not an environmental economist and only an economist who has some comments on the work of other economists.

(ii) In my perspective, the subject of this book has only limited value. The much larger, surmounting and encompassing issue in economic theory is discussed in another book, i.e. DRGTPE / Colignatus (2005) (or earlier statements). That is, my main overall advice is that democratic nations adopt a constitutional amendment for an Economic Supreme Court (ESC). Having an ESC makes that science gets a level playing field with political management – and note that Political Economy is the science of management of the state. Having an ESC makes that we have a better decision making structure to settle complex issues. The ESCs of the various nations would communicate with each other and integrate their scientific findings, and thus provide a better base for national decision making and international co-operation. Of which ecological survival would be only one of the topics. A recent statement also with respect to the current economic crisis is Colignatus (2009).

(iii) For clarity: DRGTPE takes unemployment as the key example of how the absence of an Economic Supreme Court causes a socially worse situation. For economic policy, unemployment is the key economic variable rather than income. Income is important of course and a rentier would not be classified as unemployed. But the point is that we cannot all be rentiers and the main policy issue is to keep all of us decently employed. This approach thus differs from the Tinbergen & Hueting approach to select income and economic growth as the key intermediate policy variable. Unemployment is one of the Hueting (1996) "three myths" (which analysis I agree with), but unemployment is for Hueting only a subordinate variable while he does not present a solution for unemployment.

(iv) The environment seems to me to be (only) another example of policy failure due to information mismanagement. I never have had much affinity with environmental issues though I was aware of them of course. In the mid 1990s, I had the fortunate privilege to meet Hueting. It appeared that Hueting's analysis had been much neglected in policy making and this eventually caused me first to support the Hueting Congress and subsequently to write some papers. The latter now are collected here.

My arrangement with Hueting is that I keep the issue of DRGTPE and unemployment separate from his issue of national accounting and the environment. It might be confusing for readers when such issues are lumped together. Thus this book THAEES will be limited in this respect too. This book does not expound the argument for an ESC and neither uses the environment as an example case or argument for an ESC.

(v) A red line is the choice between a "social welfare function" (SWF) and "national income" (NI) as a factor or even traditional indicator for welfare. In 1986, a draft book by me on the theory of production contained a chapter on "the horrors of real value added" with the suggestion to forget about income as the intermediate variable and concentrate on the SWF and the production function. A reorganization caused this draft to be shelved, but the episode clarifies my later focus on the SWF and Arrow's

Theorem, Colignatus (2001, 2007) when this appeared to be relevant for the analysis of unemployment. From the present angle we can also imagine an eS-SWF. Presumably, Statistical Offices will have even more problems with calculating social welfare functions and hence we stick to the Tinbergen & Hueting line of eSNI.

(vi) A final drawback of this study is that there is an aweful overabundance of repetition. A baseline is that the Hueting (2008) summary – only some 20 pages – would be sufficient for Statistical Offices around the globe to decide to construct eSNI figures and for economic policy advisors to start using both NI and eSNI in their policy advice. When more ink flows then this necessarily comes at the cost of repetition. The scope for human misunderstanding and misconception is unlimited and every angle apparently requires its own elucidation. In itself that is intellectually interesting. Hence, as in entomology, we take this insect and investigate it from all sides, focussing on each detail, and for example each leg apart, and not worrying when it appears afterwards that all six legs are basically the same, and other such repetitions. The only condition is that the research report is written well so that repetition does not become tedious or boring.

Caveat

The reader should not forget about the original publications themselves. It is advisable to actually read Tinbergen & Hueting (1991) and some other works, notably Hueting (1974, 2008) and Hueting and De Boer (2001). See http://www.sni-hueting.info. The issues are rather subtle and my way of stating issues differs from the original authors. My papers / chapters in this book approach the issues rather at a meta level while the original authors do the actual work.

Roefie Hueting
and
Sustainable National Income

Roefie Hueting (1929) put environmental economics right on the map in Holland in 1974, with his thesis "New scarcity and economic growth" (Hueting (1974, 1980)) written under promotor Jan Pen. In a sense he did so even for the world map, but the English translation had to wait till 1980 and then there were also publications by others. Hueting was head of the environmental department at CBS Statistics Netherlands since 1969, and he saw to it from the start that the environment did not remain a theoretical exercise but was described statistically and made accessible for policy making. The high quality of the Dutch environmental statistics is world famous amongst statisticians. Subsequently, in the late 1980s, Hueting enriched economic science with the concept of sustainable national income (SNI). With Hueting we thus find theory and measurement linked and closely tuned.

National accounts

To understand Hueting's work, we have to go back to the foundations of economic theory. The concept of 'national income' is founded in the theory of economic welfare. The concepts of general welfare and the national accounts have been developed in the period 1930-1960 by Tinbergen, Hicks, Kuznets, Samuelson, Bergson, Meade and Stone. Attention is focussed on the development of general welfare, while the importance of the production of goods and services is derived from this. For example, when more chairs are produced, then material production rises. However, welfare does not necessarily increase since there may be no need for more chairs.

While the main focus of interest is the measurement of general welfare, this becomes frustrated since the welfare function cannot be observed directly. It is for this reason that income is used as an approximation, as this can be derived mathematically from the tangent plane to the utility function. If one assumes that the market is optimal, then observed market prices can be used to deflate this income. This is, in a nutshell, the economic theory that forms the foundation for statistical practice.

In the period since 1960 the theory itself seems to move more to the background, and for many the national product becomes the yardstick for economic success. That was the situation when Hueting started to consider the issue of the environment.

Environmental functions

Hueting's first contribution to economic science is the concept of 'environmental function'. A component such as water has different functions or applications, such as drinking, fishing or use in industrial processing. In this, a function is defined in relation to human needs. As one of few economists, Hueting delves in ecology, chemistry and

physics, clarifies the various functions of the ecology, and subsequently identifies their economic meaning. Where environmental functions in the past were abundant and consequently did not have a price, nowadays they are scarce and do have a price. In the common calculation of national income, this increase in price is taken as an *increase in value* that causes a higher income. Here Hueting called attention to a major misunderstanding: these higher prices actually mean an *increase in cost*, so that real welfare decreases. Take for example an environmental disaster or the introduction of catalysts on cars. In these cases labour and tools are used to repair the damage. Hueting calls it asymmetrical, when on the one hand these costs are entered into the accounts and cause an increase in national income, while on the other hand the environmental damage is not substracted. This asymmetry still is current statistical practice.

Demand and supply

By scarcity, environmental functions get a price. But do they get the right price ? Is the assumption of market optimality satisfied ? As a first step to answering this question Hueting tries to specify the functions of demand and supply. His analysis has gone through a development here. In his thesis he was able to determine a supply function for environmental functions based upon elimination costs of pollution and such. For a demand function, however, he had to refer to decisions by the government and 'social forces'. He made a sharp distinction between consumer preferences and what turns up of those in government decisions, but he did not have a solution for the tension between the two.

When governments all over the world, in the wake of the Brundtland report of 1987, decided to adopt 'sustainable development', Hueting concluded that this actually implied a 'vertical demand curve'. Seen from one perspective he only follows the governments, seen from another perspective he provides an economic foundation to the notion of 'sustainability'. Just like Hueting pointed out that sustainability actually means that the freedom of future generations to use environmental functions becomes the center of focus - where the concept of freedom is wider than the concept of income, just like Amartya Sen (1999) recently did.

Two questions

Hueting answers two questions with this analysis. First, one might think that initial statistical errors would disappear when environmental functions become scarcer and the prices rise, and when the environment thus becomes a cost factor and is integrated into the economic system. According to Hueting the statistical error does not disappear all by itself. As the example of the car catalyst shows, there is still a problem with statistical accounting. Secondly, one might think that the error should disappear in a democracy in which expenditure should be close to the social optimum. However, when governments on the one hand state a choice for sustainability, but on the other hand don't implement this in practice, and when they hence do not apply the prices that are required for sustainability, then the appeal to 'democracy' is also an appeal to inconsistency. Inconsistency does not provide a basis for statistical measurement. Hueting refers to the 'prisoners' dilemma' and other arguments of government failure by which the consumer preferences are 'blocked' and cannot be expressed in market prices. With respect to the two questions just mentioned, it therefore is a misunderstanding, according to Hueting, to think 'that the information is all right'.

A correct statistical description requires another figure alongside traditional national income, namely the distance to sustainable national income. In Hueting's view, both numbers are fictitious, since he considers it impossible to know the true preferences. Publication of both figures seems to him the best solution for meeting the need for information. That need for information is clear from the discussion in society.

Revolution in statistics

Concerning the calculation of the distance of NI to SNI, Hueting actually performs a small revolution in statistics. He namely uses a *model* as an integral part of *observation,* and in this model expectations with respect to the future play a key role. Many people regard statistics as only the observation and recording of phenomena in the past. For Hueting, however, theory leads to the insight that the use of a model cannot always be avoided. [2]

Recently, the SNI according to Hueting's methodology has been calculated for Holland, see H. Verbruggen (ed) (2000). A discussion in Dutch is in Verbruggen et al. (2001). This calculation was carried out for 1990, which underlines that Hueting, as a statistician, is interested in the past, namely 1990, and not 2010. The model contains a development path to the future, with valuations by the generation of 1990 of the positions of future generations. It is striking that in this way expectations and preferences concerning the future are used to estimate a figure for the past. The approach as such is consistent, though.

The calculation incidently shows [3] that Dutch SNI is less than half Dutch NI, which would mean that the Dutch generation of 1990 lived in too grand a style and passed on too many costs onto future generations. These figures are likely to appeal more to one's imagination when more data points can be compared, with a monitoring of the distance between NI and SNI. Calculation of SNI incidently appears not all that expensive, for it is a calculation at a high aggregate level, that uses data that have already been collected for other purposes. Therefore, regular calculation appears to be possible in practice.

Conclusion

Hueting has the position of the statistician who sees it as his task to provide correct information. He is not only the theorist who goes back to Tinbergen and Hicks and he is not only the practitioner who introduces the required improvements in his field, but he is also the unwavering scientist who sticks to his role as supplier of information.

[2] Addendum: Hueting actually prefers to avoid a model as much as possible. They add to discussion of model content though with possibly little addition to accuracy. The Hueting e.a. (1992) methodology avoids models in the same manner. (This footnote was not in the original publication of this paper.)

[3] Here: see **Figure 8**.

The choice on sustainability: information or the meta-SWF approach to a shift of preferences

Abstract

If an economic system has a regime switch then we could assume that the preferences have remained basically the same but that only the state of information has changed. An alternative view is that there has been a shift of preferences as for example individual persons can change their mind too. Economic theory needs the concept of a 'meta social welfare function' (meta-SWF) in order to explain switches in preference regimes. Hueting's argument on the switch in environmental policy from laissez faire to sustainability is an interesting example for this argument.

Introduction

Colignatus (1992, 2000a, 2005) presents the extended social welfare function SWF(x ; I), where x is the allocation over agents, and where the state of information I is included in the SWF, to express in a shorthand fashion that society's choice can depend upon the state of information. The basic notion is that the SWF remains the same over the regimes, but a condition can change. Information is basically just an example for such a condition, since also another variable can cause the switch. In a sense we could allow for time as the 'explanatory' variable. Basically, of course, we can have a dynamic situation that gives the evolution of the SWF over time, with perhaps a dramatic change at the switch point. But simply designing a path of SWF(t) will not do, since economics has to model the process of choice that is involved in the making of the change. An alternative approach is to assume different social welfare functions per regime, for example SWF(x) and SWF*(x) if there are two regimes. But with different SWF's we would need a meta-SWF to explain the shift.

The issue actually holds for any regime switch. A useful example is the issue of the choice in environmental policy between laissez faire and sustainability.

The environmental issue

The environment can be seen as generating various functions that enable life and economic activity. In the past these functions were free, and thus had no price attached to them. Nowadays, however, these functions become scarce, and thus get to be priced. The (unmanaged) market price - or 'laissez faire' price - of an environmental function can be

derived as the cost that an economic agent has to make if he or she wants to enjoy the function. Alternatively, the government may impose controls to influence that price (and we get a market with controls). Choosing a correct price is important also for statistical purposes, since a figure like 'national income' is calculated while using prices.

A government can have various objectives when choosing its controls. One important objective might be 'sustainability', i.e. that the environmental functions are used such that nature can run its course, and such that later generations are not overly hindered by current uses. Hueting presents the choice for sustainability as socially optimal. "In other words", social welfare should increase as a result of the choice for sustainability. The choice for sustainability would generally mean that people would use less resources, and 'national income' as currently measured might well be lower. By economic intuition we expect that a move to a better situation is reflected in the upward movement of at least some indicator. If 'national income' goes down, then at least social welfare has to go up. This paper hopes to clarify this issue.

We will show in particular:

(a) Once sustainability has been chosen as a goal, then the social optimum is reached at the point of sustainability.

(b) The move from laissez faire to the objective of sustainability however may be a change of preferences.

(c) The latter move may well mean a *lower* social welfare.

(d) To understand the switch of preferences, economic theory needs the concept of a 'meta-social welfare function', which guides the overall selection of preferences. The switch can only be regarded as an improvement if it is determined as such in the meta-SWF.

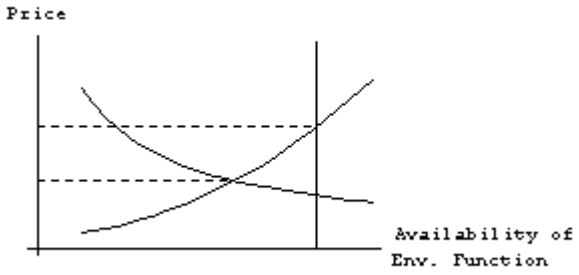
A meta-SWF is, in itself, not too difficult to understand. In the same way a person can change his or her mind. Also, an older generation may prefer laissez faire, while a younger generation may choose sustainability, and hence eventually there would be a switch of preferences.

It follows, therefor, that the discussion on sustainability may be a bit more complex than originally thought.

Basic concepts

Figure 1 is the, one might say, renowned Hueting graph of the relation between an environmental function and its price. The upward sloping curve gives the producer costs ('supply'), found by looking at the costs of making the function available - such as water clean-up. The downward sloping curve gives the laissez faire user costs ('demand'), based upon such laissez faire prices. It could be constructed from the efforts by the agents to compensate for the loss of function by choosing other activities or using other resources. These costs should be added to give total unit costs. The suggestion is that the observed choice is at the minimum of this summed costs. Basically, though, a social welfare function would select the observed point, by balancing the environmental costs with other objectives (not shown). Anyway, statistically, we could observed the implied price (total cost) at 'observed preferences'. Alternatively, society imposes a norm of higher availability, and then the intersection of the vertical norm and the cost curves gives the normed price.

Figure 1: Environmental function and its price



Incidently, society's norm will be derived from individual preferences. It has been conjectured by some, in verbal discussions, that Hueting would 'impose' the norm of sustainability. This however appears to be a misunderstanding. The difference between the laissez faire situation and the normed situation appears to derive from different considerations - as holds regime switches in general.

Model

It will be useful to model the problem. Let us consider two non-overlapping generations who 'share' 100 units of oil and 100 units of water. The first generation will make the decisive decision how much to use itself, and it will bequeath the remainder to its descendants. To do so, the first generation uses a social welfare function (SWF), which function not only contains its own direct income y_{Now} but also the indirect welfare that it derives from the situation for the descendants. This indirect welfare is based on the direct income y_{Future} that the descendants are hypothesised to achieve. We follow Ramsey in a lack of a rate of discount.

The SWF will here be a Constant Elasticity of Subsitution (CES) function that neglects the distribution of income. Next to an 'egotistic' base situation SWF, we regard the alternative SWF* in which society switches its preferences so that it becomes more understanding of the needs of future generations. The SWF* includes a bonus welfare injection that derives from making the switch:

$$SWF = \left(0.7\ y_{Now}{}^{-\rho} + 0.3\ y_{Future}{}^{-\rho}\right)^{-1/\rho}$$

$$SWF^* = \left(0.5\ y_{Now}{}^{-\rho} + 0.5\ y_{Future}{}^{-\rho}\right)^{-1/\rho} + bonus$$

The income of the generations is determined by production functions that depend upon the allocations of the factors of oil and water. With a constant technology, and i = Now, Future:

$$y_i = \left(0.4\ oil_i{}^{-r} + 0.6\ water_i{}^{-r}\right)^{-1/r}$$

Graphs

We solve the model by the program originally developed by Noguchi (1993) and further developed by Cool (1999). In the plots, the base 'egotistic' situation has continuous lines, and the alternative 'sustainable' situation has dashed lines. We use $\rho = 2/3$ (σ = 3/5) and $r = -2/3$ ($\sigma = 3$). We also assume that the switch *bonus* = 0.

Figure 2 plots the production possibility curves and the SWF indifference maps of the two situations. Clearly the alternative SWF allows more consumption for the future generation.

Figure 2: Production Possibility Curves & Indifference Maps

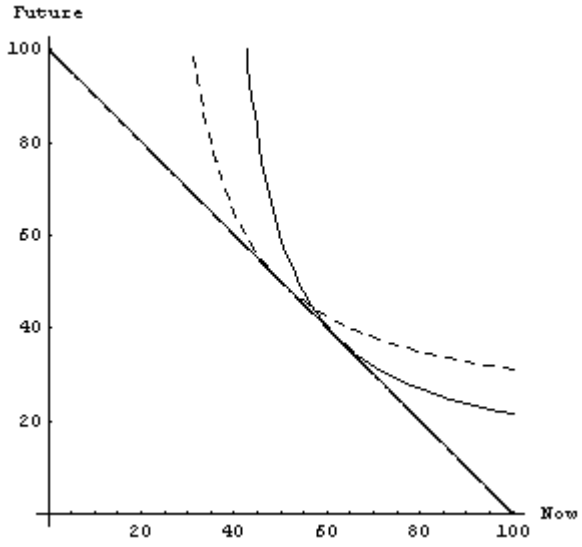


Figure 3 plots the Edgeworth-Bowley diagram, with Now in the lower left and the Future in the upper right. The movement is downwards along the contract curve. Since the production functions are the same, the contract curve is a straight line. Consequently, the percentage that a generation takes of the resources is the same for all resources.

Tables

The following tables give the numerical outcomes of the two regimes. The social optimum is found as in Table 1. The associated allocations are in Table 2 - left and right side. Given our simple assumptions, we also get a simple result. When you compare the two regimes, please note that the prices are normalised *per regime* to a unit price for Now, and thus are not comparable over regimes.

Figure 3: Edgeworth-Bowley Diagram

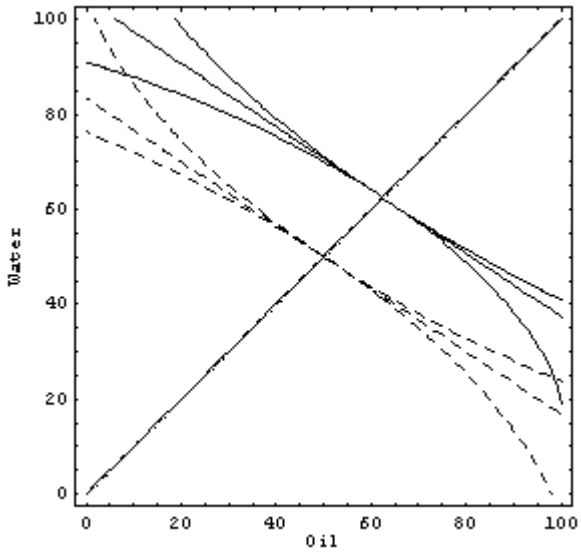


Table 1: Utility, production and national income for two regimes

	Utility level	*National income*	*Product prices Now & Future*		*Production Now & Future*	
Base	52.6	100	1	1	62.5	37.5
Altern.	50	100	1	1	50	50

Note: All prices are scaled so that the product price of the Now-sector = 1. This is also done per regime, so that the price levels over the regimes are not comparable.

Table 2: Allocations

	Base		*Alternative*	
	Oil	*Water*	*Oil*	*Water*
Now	62.5	62.5	50	50
Future	37.5	37.5	50	50
Total	100	100	100	100
Price	0.4	0.6	0.4	0.6
National Income Share	0.4	0.6	0.4	0.6

Closer understanding

We arrive at a closer understanding by regarding two other graphs. Let us choose water allocation at the optimal level, and vary the allocation of oil. **Figure 4** shows the SWF and SWF* graphs as functions of the allocation of oil to the Now generation**. Figure 5** plots the output levels of the Now and Future generation. Output of the Now generation goes up when it uses more and more oil. At the same time the resource for the Future generation goes down, and hence income goes down. As the income of the Future generation reduces then this eventually affects the social welfare of the Now generation as well.

Figure 4: Maximising SWF

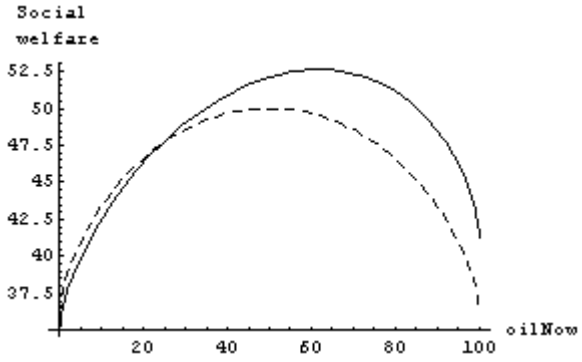
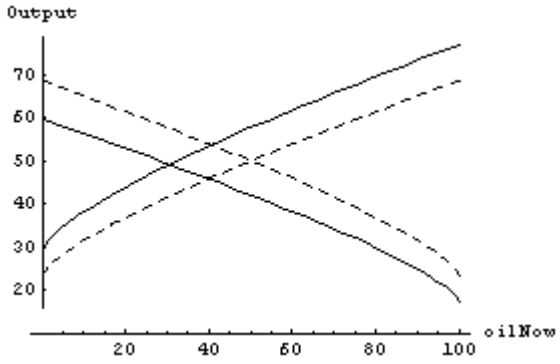


Figure 5: Output



We now can understand the Hueting graph a bit better. The switch from the laissez faire situation to the normed 'sustainability' situation can be a switch from one SWF to an alternative SWF*. The horizontal axes in **Figure 4** and **Figure 5** give depletion, which is the opposite of availability. Due to the higher preference for presumed future

consumption, current output becomes less and future output goes up, and hence the availability of the resource goes up as well.

In this example, we see that the absolute value of social welfare is *less* in the new situation. Lesser consumption Now is compensated by a benefit to the future generations, but not fully. With ordinal welfare, this does not mean much of course. If we assign meaning to the numerical values, however, then a non-zero switch bonus is required. In this case the bonus should be at least 2.6 welfare function points (or output to that effect). In a general approach, we would need a meta-SWF to choose between the SWF and SWF* - i.e. to deal with that constant. Such a meta-SWF would automatically assign a value to the different welfare scales.

Alternatively, if we use the SWF(x; I) approach, then the regime switch could be the result of a change of the state of information from $I = 0$ to $I = 1$, and we would get SWF(x, 0) = SWF(x) and SWF(x; 1) = SWF*(x). By implication the two welfare scales are considered to be comparable, and the *bonus* would be the implied value of the information.

This discussion thus corroborates Huetings position, but adds a useful clarification. This analysis also shows that there is scope for research on how people's choices are affected.

Hueting's position might be interpreted as: *If* society decides for sustainability, then apparently this is an (meta-SWF) improvement. A problem with this position could be Hume's gap between Is and Ought. From observing a certain situation, we cannot conclude that it apparently is optimal. However, Hueting's position would be valid if the emphasis is on 'decides'. If society *decides*, i.e. aggregates its preferences, to sustainability, then this by definition gives the new social preference. But for the same reason, it is not obvious that society would make this choice. It might as well think that sustainability has no *bonus*. Note for example that the SWF* optimum certainly is lower in terms of the original SWF, so some people who think in terms of the original function will have a hard time to see the improvement.

Conclusion

We clarified that regime switches can be represented by the information approach or by the meta-SWF approach to preference switches. And we showed that these are to some extent equivalent.

Using this, we clarified the discussion on the policy choice on sustainability.

This analysis also shows that there is scope for research on how people's choices are affected.

Appendix: Program

The (relatively short) Economics Pack program to produce above results can be found in Colignatus (2000b) on the internet.

The Old Man and the SNI.
A review of advance and adversity in Hueting's research in economic growth and the new scarcity from the environment and sustainable national income (SNI)

"'If you are not tired, fish,' he said aloud, 'you must be very strange.'"

Hemingway (2004:50), "The Old Man and the Sea"

Abstract

Roefie Hueting (1929), recently turned 79 years of age, has been working on the subject of economics and the environment since around 1965. Seminal results are his notion of environmental functions (WWF, 1969), his Ph.D. thesis "New Scarcity and Economic Growth. More welfare through less production ?" (1974), the definition of (environmentally) sustainable national income (eSNI, UNEP/World Bank 1989), the eSNI methodology (CBS Statistics Netherlands 1992) and his contributions to the 1999 Hueting Congress (presentation and rejoinders, 2001bc). The figure of national income NI gives production while the figure of eSNI gives the production level that maintains the availability for future generations of the vital environmental functions. For many economists, the current focus is on climate change but the ecological challenge is much wider and more fundamental, see also the Convention on Biological Diversity, Bonn 2008. The figure for eSNI still isn't included in the system of national accounts (SNA) which means that current statistical reporting on national income and economic growth provides incomplete information to policy makers and the general public. With the dictum "What you measure is what you get", we currently get "economic growth" that works against sustainability. This review provides a reflection on advance and adversity in 40 years of Hueting's research in a world that only slowly recognizes the global environmental problem. How do governments decide under risk, how do they grow aware of that very risk, what is the role of the national statistical offices in providing information on that risk, especially when that risk concerns survival for large sections of the planet ? The reflection provides insights that themselves are useful for our understanding of the political economy of research on issues that are politically sensitive.

The author thanks Roefie Hueting, Bart de Boer, Robert Goodland, Salah el Serafy and Henk van Tuinen for valuable comments. Hueting has expressed that the paper reports correctly on his work, which is important to mention since his work is often misrepresented. All errors remain mine.

1. Introduction

1.1 A topic in political economy

In 2006, the film *An inconvenient truth* by Gore et al. (2006) caught the public's fancy while the UK *Stern Review* (2006) provided an impetus for economic policy making to recognize the problem of climate change. At bottom, it are not these publications but the experiences of abnormal weather patterns and some disasters like the 2005 Katrina hurricane that caused the world to pay attention. In 2007, both the Intergovernmental Panel on Climate Change (IPCC) and Mr. Gore received the Nobel Peace Prize "for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change".

Yet, these issues have been known for much longer. Also, the true ecological challenge is much wider and more fundamental and quite a lot larger. Even if climate change is kept within limits then there still remains the proper issue of environmental exhaustion and destruction of the ecological base for large sections of the planet. Braat and Ten Brink (eds) (2008) review the challenges for the Convention on Biological Diversity, but this is only a part of the whole issue, since the issues of e.g. erosion and pollution have a wider impact than only on biodiversity. Tinbergen & Hueting (1991) estimated the challenge of environmental sustainability at around half of world income. A calculation for The Netherlands by Verbruggen et al. (2001) gives approximately the same value. The result will not differ much for other advanced countries. If Joe and Jane Sixpack are to become sustainable, their income would need to be halved, which implies a reallocation towards activities that are friendly to the environment. The economic challenges for sustainability thus are enormous, and they often are not properly recognized in full for what they are. Indeed, the UK Stern Review (2006) arrives at 5% to 20% albeit only for climate change – which differs importantly from 50%.

Why is this challenge not properly recognized ? Since recognition depends upon information, a major aspect in answering that question concerns the management of information. The question then becomes: how do we deal with the information about our economic activities (that affect the environment) ? To understand the Tinbergen & Hueting (1991) and Verbruggen et al. (2001) estimates we need to consider the national accounts. In economic theory, national income (NI) expresses the annually available production level available for consumption, as a factor for optimization of social welfare. Economists have been designing various "green GDPs" such as ISEW, Ecological Footprint, Genuine Savings, Genuine Progress Indicator, and the like. Of these indicators, Hueting's concept of (environmentally) sustainable national income (eSNI) gives the production level, associated with NI, that maintains the availability for future generations of the vital environmental functions, i.e. the possible uses of the non-human made physical surroundings. The value of those functions is what society is willing to sacrifice to keep them. Of the various indicators only eSNI satisfies the basic condition on the environmental functions. eSNI thus would warrant our attention as the indicator of interest for sustainability. Using Lional Robbins's Leitmotiv of the allocation of scarce means for competing ends, the levels of NI and eSNI provide information for deciding on the satisfaction of the ends of production growth and sustainability. With various governmental statements, research reports or newspaper articles discussing sustainability, the natural question to ask is "how far are we from sustainability ?". To

answer that question we need eSNI, for the difference between NI and eSNI exactly gives that distance, and expresses the economic challenge to achieve environmental sustainability. According to Verbruggen et al. (2001) eSNI ≈ 50% NI, which is the "half of income" mentioned above. And here we arrive at part of the answer to our question on the management of information. In the United Nations System of National Accounts (UN SNA) only NI is listed as a measure while eSNI is not listed. The national statistical offices around the world only publish data on NI but not on eSNI. A well-known dictum is: "You get what you measure." Currently we measure NI and get more NI, but for sustainability we rather should measure eSNI alongside NI and get more eSNI.

The usefulness of eSNI shows less from the absolute level and more from the dynamic development over time, where the unyielding laws of arithmetic come into play. Suppose that, with NI at 100 and eSNI at 50, NI grows by 5% to 105 and eSNI drops from 50 to 49, then it is obvious that such growth is unsustainable. Suppose that policy is adjusted so that eSNI would grow by 5% too, then we get an eSNI of 1.05 * 50 = 52.5 in terms of the original year. But then the absolute gap has also increased. With NI now at 105 and eSNI now at 52.5 the absolute gap has grown from 50 to 52.5 in terms of the original year. If we want to maintain that absolute gap, eSNI would have to grow twice as fast, at 10%, and if we want to close the gap it has to grow even faster. In this way, eSNI provides information on the direction and speed of the sustainability of economic development.

We can see that eSNI provides crucial information for monitoring economic policy with respect to environmental survival and the sustainable availability of environmental functions for future generations. The key question in this review is: why is this figure not standardly available as information for national economic decision making ?

It is a key question indeed. The planet confronts a huge environmental challenge, with world population rising from 6 towards 9 billion in a few decades to come, and 15 years can mean a difference of 1 billion. Both national income & production growth and their sustainable varieties provide important indicators or factors for economic welfare and guide us in the allocation of resources. If an indicator like eSNI does not make it to the official publications, is not used in policy discussion and is not printed in daily newspapers to inform the general public during national elections, then the general presumption is that this indicator is not necessary. The presumption is that we live in an information society, the world is a village, our scientists and economists are well-trained and have sharp critical minds. "Surely," people think, "if an indicator would be required, we would already use it." Somewhere that presumption however fails. The present review will paint the mixed picture of how that became possible. The true cause in the background for the non-presence of the eSNI indicator might have been human fallibility or a general belief in economic growth. Yet the events reviewed here mark the opportunities, both taken and missed, and it is important to see that key opportunities actually have been missed. It will require a deliberate action to get eSNI into the official publications.

For economics, there appears to be a theoretical crisis at the very roots. Historical forces are at work here. The economists who designed the theory of social welfare and national accounting, economists like Jan Tinbergen, Paul Samuelson, Simon Kuznets, John Hicks, James Meade and Richard Stone, were leaders in their generations and made their presence count in more areas. All received Nobel Prizes. Sir John Hicks once commented that accounting may be the prime contribution of economics to mankind, e.g. see Hicks (1983:365-375). Once the system of national accounting was in place, it

became a matter of operational activities and the leading economists of our own time have been inclined to be concerned with other issues. Indeed, Bos (2007) states: "Among economic researchers there is a worldwide illiteracy in national accounting. A decade ago, national accounting has been dropped as a separate topic of research on the list of the Journal of Economic Literature. The economic researchers skilled in national accounting have become more and more extinct." Of this disappearing breed, again only a few noted the relation between the environmental challenge and national accounting. A consequence has been that national accounting does not provide us with a figure of eSNI for policy making. The theoretical crisis in economics is that social welfare theory and national accounting got separated which tends to destroy the very basis of what the whole exercise was intended for. On this historical stage, this review now considers the work done by Hueting.

It are ethics and morality that deal with survival. The ethical issue features strongly in this discussion. Above figure of eSNI uses data for the small country of The Netherlands, though derived from world data when necessary. However, the proper question is: how can it be that figures for eSNI are lacking for other modern and much larger nations ? How do intelligent people deal with the situation that their grandchildren are at risk that their environment is largely gone ? Apparently there are not only blind spots in economic policy making with respect to our physical surroundings, causing governments around the world to pursue the goal of NI, but there are even blinding mechanisms that make us unwilling to generate the information on eSNI that clarifies what we actually do. Mechanisms that blind us even to risks for survival, the risk of non-survival and the possible destruction of the ecology that mankind depends upon. The study of this phenomenon is a topic of political economy. Why is it, and, more specifically, how is it, that developed democracies harbour such mechanisms that close their eyes to the issue of survival ?

1.2 Making a compass for economic policy on the environment

The Dutch economist Roefie Hueting (born 1929) has been studying and writing on this issue for 40 years and has given a seminal contribution to our understanding of how the environment enters economics and economic theory. Results are his notion of environmental functions (WWF, 1969), his Ph.D. thesis "New Scarcity and Economic Growth. More welfare through less production?" (1974), the definition of (environmentally) sustainable national income (eSNI, UNEP/World Bank 1989), the eSNI methodology (CBS Statistics Netherlands 1992) and his contributions to the 1999 Hueting Congress (presentation and rejoinders, 2001bc). A very useful summary is Hueting (2008). His findings received support from Jan Tinbergen, see Tinbergen & Hueting (1991), where Tinbergen is the Dutch economist who joined Ragnar Frisch in the first Nobel Prize in economics. Hueting wrote extensively and contributed to various conferences of the United Nations, OECD, the European Union and separate countries such as India and Indonesia. He was awarded the Dutch royal knighthood and in 1994 the UN Global 500 Award. Yet, one of his prime suggestions, to calculate a figure for "(environmentally) sustainable national income" (eSNI) alongside the common figure for "national income" (NI), is still not adopted by the international community of national accounting. Only the Dutch government has provided funds for some calculations, for the years 1990, 1995, 2000, while the calculation for 2005 is in progress. But somehow, there it stops. All this is amazing since it would be rather obvious that policy making requires sound information if it is to be effective. In the current situation, various data on the risks of environmental collapse are used, yet only fragmented so, and the issue is to

turn these data into information, i.e. by constructing an aggregate measure for the distance to sustainability.

The concept of environmental functions, the possible uses of the non-human made physical surroundings, including eco-systems and life support systems, on which humanity completely depends, is the basis of Hueting's approach. In the case of (actual or expected) excessive use at the expense of another or the same function, functions have become economic goods by definition. Environmental sustainability then is defined as safeguarding vital functions for future generations.

This review deals with some events of advance and adversity in this research. This paper is targetted to highlighting some key mechanisms.

To properly value this review it is useful that the reader knows a bit more about Hueting's analysis. Van Ierland et al. (2001), already referred to, also contains a chronology by Goodland (2001). Colignatus (2001) gives a two-page review, and more will transpire further below. A useful source is also Hueting's website at www.sni-hueting.info.

A key point in Hueting's theory is that both NI and eSNI are conditional concepts, in other words "what if" figures based upon assumptions. Preferences on the environment and the new scarcity cannot be expressed by the market when that market is left by itself without ideal regulation that truly reflects the preferences – including the complex question how to aggregate preferences when some prefer sustainability and others don't. NI is conditional on the assumption that the package of goods – produced goods and environmental functions – becoming available in the study year perfectly reflect the preferences of the subjects (which cannot be measured). Thus, NI is conditional on the assumption that all preferences are expressed in the observed data, even though it is not certain that the individual preferences actually are expressed in those data. eSNI is conditional on the assumption of preferences for sustainability. Both indicators provide only information and don't imply a position on the subject. This conditionality is quite common in scenario studies. Nevertheless, NI is commonly misunderstood while eSNI is not generally accepted yet.

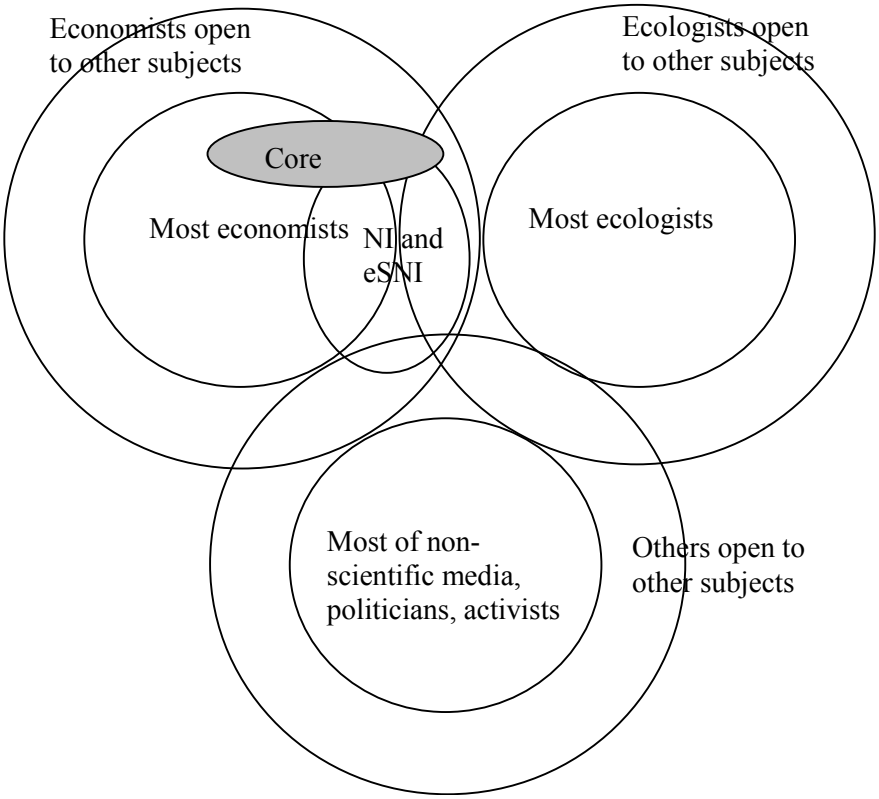
How much does it cost to calculate an eSNI ? Let us consider the budget of CBS Statistics Netherlands with 2,500 employees. There are general costs in collecting data. These data are subsequently processed in different specialized departments. Of these high level departments, the Consumer Price Index costs 1.3% and the department of national accounts costs 4.2% of the budget. Calculation of eSNI costs 0.25% of the budget. The 0.25% for eSNI is only possible because of the integration of work processes, where the environmental data are already collected for other purposes and where the calculation involves corrections at a relatively high level of aggregation.

1.3 A guiding diagram

Figure 6 depicts relationships that are relevant to our discussion. The grey oval gives us economists working in the "core of economics". Around them there are economists and ecologists, and agents who tend to be none of these, such as media people, politicians and societal activists. It are primarily specialists who understand a decent amount of both economics and ecology. Most economists concentrate on their own subject and similarly for ecologists. Around these majorities there are zones of co-operation. National accounting can be studied with different degrees of openness. Ecologists open to

economics but without knowledge of national accounting will miss out on eSNI. An author like Hueting who is an economist open to the subject of ecology and who works in the field of national accounting, clearly will be little understood by others with different positions. Even societal activists who lobby for a better environment are likely not to understand him since he is not an activist but an economist speaking the language of national accounting. The discussion will stagnate unless bridges of communication are built and unless greater desires arise to understand what eSNI is about.

Figure 6: A diagram of relationships



The diagram may strike the reader as a bit superfluous. Once these different positions are identified, it becomes obvious that there will be miscommunications. However, it is a major step towards comprehension of environmental economics and policy to see that the field is so fragmented as it is. The fragmentation of knowledge may cause perverse effects. To understand the issue of eSNI requires 100% clarity on the subject, and, while many arrive at 90%, each researcher misses a different 10%, and each 10% may be sufficient for the issue to be rejected. For example, many think along the lines "different assumptions, different eSNIs" but in Hueting's perception (i) there are different green NI's but only one eSNI, (ii) within eSNI the uncertainty only causes different estimates but does not invalidate the concept. Points (i) and (ii) provide decision makers with a framework of decision making under risk. The scope for misunderstanding is huge.

Subsequently, the diagram will guide and enlighten the discussion below where we can identify actors and where we can explain advance and adversity due to positions.

The "core of economics" is not at the center of "most economists" and even overlaps with the fringe. Hueting works on the subject of scarcity and describes the environment as the "new scarcity", so that his work can be seen as belonging to the "core of economics". Most economists however see it as still on the fringe.

With scarcity as the core of economics, only a subgroup studies social welfare and national accounting *and* has some interest in the new scarcity of the environment. This subgroup is fragmented as well. Core subgroup 1 includes Hueting, Tinbergen (deceased) and the author, who support the inclusion of eSNI in the UN system of national accounts (SNA). Core subgroup 2 includes the current London Group of the UN statistical division and opposes that inclusion. Core subgroup 3 includes those researchers who are ambiguous or have no clearly voiced opinion. Below we will consider the various positions.

Not included in the diagram are economic paradigms. A new paradigm is "evolutionary economics" that sees itself as different from "neoclassical economics", and which is altogether something else than "ecological economics". Though Hueting sees himself involved only with national accounting, he may also be classified as neoclassical, which explains part of the communication gap within economics itself and with the new approaches of our time.

Not included in the diagram is the distinction between the academic world and the national statistical offices. As mentioned, the intellectual gap between these realms has grown large. In the 1930s academics were brought into government service to develop the system of national accounting but somehow the exchange dropped to a minimum once the system was in place. Academics who invent some indicator of economic welfare commonly have students who write theses so that islands of quotations arise, while methods can be copied around the world. Examples are ISEW, Ecological Footprint, and Genuine Savings. An analysis like eSNI has to blossom in the bureaucratic environment of national statistical offices, which means that it may have little chance to do so and that it neither has an easy link to the outside academia. Clearly, an academic will not quickly write a National Science Foundation research application for something that should be done at the national statistical office. Also, an emphasis has grown in the academic journals on econometrics and mathematics such that a conceptual approach basically relying on high school mathematics and a lot of tedious calculation falls out of favour.

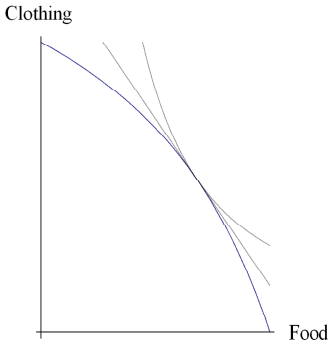
Given this fragmentation of knowledge, it may only be the ongoing destruction of the environment and the impact that this has on the economy and human survival that causes us to have some interest in the present subject. Unfortunately, times of crises may also cause people to focus more on their own and to listen less to others. Perhaps the moment of imminent danger is the most fruitful for a change in thought.

1.4 National accounting

National accounting integrates ground material into a consistent set of accounts at an aggregate level. Economic analysts and models might use the basic material but would have to create such a consistent set as well so that there is some advantage when everyone uses the same set.

Though the notion of scarcity applies to all resources, the focus in traditional economics is on activities valued in money to keep matters practical. Nominal values are collected already for tax purposes ("statistics" derives its name from measurement of "state" activities) and one challenge for economic theory is to find the split between price and quantity. A basic issue is to compare two points in time and to determine whether welfare has increased or not (at least as far as welfare is influenced by production). Since the Bergson-Samuelson social welfare function (SWF) cannot be observed, income - that follows from the tangent hyperplane - can be used as a proxy, and observed market prices can be used to deflate to real values. **Figure 7** gives an example with a production possibility curve (PPC) with food and clothing. An indifference curve of the social welfare function (SWF) selects a point along that frontier. At that point the two curves are tangent and the line of tangency provides the income level and the prices for which food and clothing are traded. With an improvement in technology, the PPC shifts outward and the SWF selects a new point. How much the SWF has improved cannot be determined since the function is not observable but the shift means that "more" indeed is "better", and calculations on observable income will generate traditional "economic growth".

Figure 7: A production possibility curve (PPC) and a tangent to the social welfare function (SWF)



Thus there are three elements to keep in mind: (i) the basic context is economics and it is only secondary that this venture applies statistics, (ii) the basic statistical challenge concerns not income *per se* but the development of welfare, and it is useful to keep welfare in mind when considering the proxy, (iii) observed market prices are used because of the assumption of optimality - whence tangency. Hueting simply proceeds in this tradition of research and sees what happens when the environment becomes scarce, now or at some future moment, while there are no market prices. Overall, Hueting's contribution derives its power from accepted notions of welfare analysis and the framework of national accounting, and indeed from Lionel Robbins's definition of economics itself as the allocation of scarce means over competing ends.

Throughout the economics profession there is recognition that the interpretation of "national income" as the only factor for welfare tends to break down. This conforms with Hueting's analysis. Above approach to NI assumes that preferences can be expressed in market prices but we know that the market may be inadequate. Though non-market aspects have been recognized since Pigou if not earlier, such considerations had little

influence in the formative years 1930-1950 of national accounting, and only later gained importance. Over the course of years, various researchers became dissatisfied that nonmonetary elements of welfare such as unemployment, labour conditions and the distribution of income were not included in the NI figure. At issue for us, now indeed, is the question how to deal with the non-market aspects of the environment.

There is a distinction between Hueting on eSNI and the statistical bureaus. There are two books that provide guidance here: De Vries et al. (eds) (1993) and the thesis by Bos (2003). These books mention the challenge of the environment but undervalue Hueting's contribution so they need to be supplemented by his work.

Bos (2003:25) gives a key insight on the thinking by national accountants (and see as well below on the connection between Hueting and Mishan):

> "In the late sixties and the beginning of the seventies, national income was frequently criticised for not being a welfare measure (e.g. Mishan, 1969; an example of an earlier critique is Margolis, 1952). However, the authors of the international guidelines did not intend to provide a measure of economic welfare. For example, Jaszi even regards as one of his principal contributions to have resisted successfully to "the will-o'-the-wisp of forging national output into a measure of economic welfare. I was a minority of one in a company that included such mental giants as Simon Kuznets and John Hicks, and at one point I had to defy a forceful Secretary of Commerce who had instructed the BEA [Bureau of Economic Analysis of the USA] to prepare a measure of welfare" (Jaszi, 1986, p. 411; a similar opinion is expressed by Stone, 1974, and by Stone, 1986, p. 457). According to Okun, "[the] beauty of ... present practice is that no sensible person could seriously mistake the GNP for [a measure of total social welfare]" (Okun, 1971, p. 133)."

The national accountants at the statistical offices see themselves confronted with various economic theories such as Keynesian economics, input-output analysis, neoclassical growth theory, monetary theory, general equilibrium analysis, and (particular instances of) welfare economics - see Bos (1995). Their response has been to choose a multipurpose system with a standard core and supplementary modules depending upon user defined theory. This *economic statistical* core must be distinguished from the *economics* core in **Figure 6**. The approach is "institutional" instead of "analytic", where the institutional approach deliberately maintains distance from any particular economic theory. There is a "Dutch view" to keep that statistical core as small and constant and internationally comparable as possible. Reich (1993:266) summarizes this Dutch view as: "What is a core ? We mentioned that it is (a) rather close duplicate of the 1968 SNA [;] the Dutch school sees the system which today we call the system of national accounts and which in their terminology is the core, as essentially inflexible in that it serves only one purpose and no other. New systems must be designed to produce information for which the core cannot properly be used. And these are the modules." Bos (2003) clarifies that the primary data are shaped into some "universal model" of processed data.. These "data" are "for the user". Data are generated, we can do calculations on them, but the figures have no explicitly defined theoretical economic meaning (other than such an "universal model"). For example, the national accounts have a concept of income that matches Keynesian analysis but a general equilibrium approach could impute income from durable consumer goods.

We may consider whether this present statistical situation was also the historical situation in 1930-1950. Kuznets and Hicks held that national accounting finds its *raison d' être* in welfare theory. Economists like Jan Tinbergen and Richard Stone may have been more practical. Tinbergen (1993:13) mentions: "Demand for them [national accounts] came originally from curiosity about the differences in economic strength among nations." His subsequent discussion extends on the practical applications and not the theoretical interpretation. Nevertheless, Tinbergen (1985) on the optimal social order puts "welfare" in the title and speaks about "counterproduction" where Hueting uses the term "asymmetric entries", so the welfare context is obvious. The extensive economic research by Hicks and others has clarified that notions such as 'strength' are theoretically unsatisfying and that a basis in welfare theory is a satisfactory approach. If a notion like income is an economic concept and if economics deals with scarcity then national accounting falls under welfare theory. However, it cannot be said that such a conclusion must necessarily satisfy everyone.

1.5 A guiding table

Over time, economists have extended social welfare theory with notions on the environment etcetera that are intended for accounting (such as ISEW, Ecological Footprint, etcetera). These ideas lead to broad indicators. However, as Hueting & Reijnders (2004) clarify, broad indicators can be misleading for survival because they can give positive signals while sustainability decreases.

Clarity in this discussion can only be achieved by some classification with a small example. Let production consist of f = food and c = clothing. In traditional economics, social welfare only depends upon production, in this case as SWF[*f, c*] with NI = $p_f f + p_c c$ e.g. in prices of a base year. "Economic growth" is traditionally linked to the growth of NI. In contrast to traditional economics, a broad concept of welfare arises when we consider other factors such as d = the income distribution, u = unemployment, r = the rest (labour conditions etcetera) and s = sustainability. In this case we get SWF[*f, c, d, u, r, s*] = SWF*[NI, *d, u, r, s*]. Hueting emphasizes broadness, as he distinguishes welfare from NI, and where he relates NI to "production growth" instead of "economic growth". While Hueting emphasizes broadness he does not want to measure welfare in one indicator, but wants to measure the factors that influence welfare separately. In his practical research he chooses to focus on sustainability, that cannot be substituted with other sources for well-being. The resulting situation might be denoted as SWF**[eSNI, *d, u, r*]. Both NI and eSNI are based upon assumptions concerning preferences. The choice between SWF* and SWF**, or regime switch, might be represented by a meta-SWF, see Colignatus (2000b).

Given these relations we can find statements in the literature like "NI is the indicator for welfare" (traditional), "NI does not cover welfare" (broadness), "NI and eSNI are some of the factors that influence welfare" (broadness, Hueting), which can be somewhat confusing, but should be clear now.

Intermediate between NI and eSNI, Hueting also defines a "NI without asymmetric entries". Overall guidance is provided by **Table 3** (and see there for the definition of asymmetric entries). The three indicators NI, NI minus asyms and eSNI and the (other) separate factors (or even indicators of factors) are required to monitor economic development.

Table 3: Economic indicators

	Social welfare function (SWF)	
	Traditional economics	*Broad indicators*
Traditional economics	NI	B
No asymmetric entries	NI minus asyms	(B minus asyms)
Sustainability	eSNI	BS

Asymmetric entries, here abbreviated to the neologism "asyms", mean that loss of environmental functions is not entered in NI, and this is correct because our physical surroundings fall outside of NI, but their restoration and compensation are incorrectly entered as value added in NI, which is incorrect because they should be entered as intermediate deliveries (costs).

Figure 6 interacts with **Table 3**. We can distinguish researchers interested in theory or not. Over time, economists interested in theory primarily concentrated on broadness. The historical alliance between policy making and economic theory that convened on NI has since eroded, and, while policy making still focussed on NI, the theorists went off to new horizons. A recent development is called "beyond GDP" with a focus on "happiness", with roots in much of the earlier literature. [4] An important practical point is that national accounting has been operationalized by its theorists and designers in such a manner that it doesn't seem to require theory any more. Statisticians can collect data and can construct aggregates and indices without resort to the finer details of welfare theory. In circles of national accounting, a philosophy has arisen of "measurement without theory". Market prices are used, not because of their theoretical content but because they are merely "observed". That "NI at constant prices grows" has become to be seen as a goal in itself, with the criterion "more" rather than "better", whatever "more" means. Hueting has had to grapple with all these developments.

1.6 A summary deduction

Hueting, in 1969 as well, focusses on the foundations of economics and the notion of scarcity. His treatment of the economic decision problem can be classified as "welfare economics" but in that sense all economics is "welfare economics" and "welfare economics" a pleonasm. Crucially, foundations are at a different level than various competing theories at a higher level. Keynesian economics, input-output analysis etcetera are higher level theories that rely on notions of scarcity and individual decision making as furnished by foundational economics. Thus:

(i) the figures constructed by the statistical agencies, such as unemployment or national income, have lost the interpretational framework of traditional welfare economics

(ii) no higher level theory can repair that deficiency,

[4] Addendum: Clark, Frijters and Shields (2008) give a good review, exclusive of environmental sustainability.

(iii) thus these figures are without adequate theory at the foundational level.

The distinction between the analysis at the foundations versus the higher level economic theories can also be formulated in a different way. A more standard interpretation is the degree of openness of the researcher to the ecological challenge. When the researcher is mentally closed to the ecological challenge then there is no need to adapt the foundations of economics. When the researcher is open to the challenge, as e.g. recently formulated by Diamond (2005) "Collapse", then there is scope to reconsider the foundations of economics and include the new scarcities. **Figure 6** has been formulated in terms of this more standard interpretation of "green accounting". However, when we consider the choice by national accountants on what to include in SNA then this standard interpretation on greenness distracts from what is relevant in terms of construction of theory.

We can categorize some possible causes for misunderstanding. (1) Not to see that Hueting's analysis is fundamental for the subject of economics itself. (2) To reject that Hueting's analysis affects not just the core of economics but also *all* economic approaches such as Keynesian economics etcetera, and thus also above "economic statistical core". (3) To categorize his approach as a specific application of welfare economics or environmental economics, and thus see it as only one of the many possible uses of the data. (4) To accept the development of a module on the environment as part of the statistical task but not a module on eSNI. (5) To reject a choice on the "core (economic or statistical) model" when it is not accompanied by an insistence that economic theory solves the theoretical gap on the foundations.

These points clarify the current theoretical crisis in economics. We are tempted to describe the situation as an institutional gap between (a) economists interested in theory (such as ISEW, Ecological Footprint, etcetera) and (b) the operational economic statisticians at the national statistical offices. To some extent this is a useful description since these different authors started to write and publish for different audiences, so that this crisis at the root of economic theory does not resound in the economic literature at large. On the other hand this is not quite the proper description since the economic statisticians are aware of the various economic theories. Their choice to be 'as neutral as possible' has been guided by theory. Koopmans (1947) is a classic paper about measurement without theory. To some extent this approach is present when a figure for "national income" is published that no longer has a specified theoretical base. There is a viewpoint that it is not quite measurement without theory when there are these competing theories, while Bos op. cit. mentions that observation in itself always depends upon theory. Yet, nevertheless, these competing theories, such as Keynesian economics or input-output analysis, are high-level theories and differ from foundational analysis.

National accountants have been put into a position where they as economics statisticians have had to decide on what is proper economic theory, and they have responded by declining such a choice. Their response 'not to choose' is deficient when it is not accompanied by an insistence that economic theory solves the theoretical gap on the foundations. Their position most likely comes about because of disinterest by influential economic theorists and because of a rejection of Hueting's analysis as an influence.

Hueting solves the theory gap in an essential way. Not by providing an indicator for total welfare.. Not by restoring the paradise of tradition. But by restoring the context of economic decision making.

PM 1. Interestingly, as an accountant Hueting sticks to the concept of income rather than welfare.

PM 2. It is a bit immaterial whether eSNI is calculated at the statistical core or as a module. Both NI and eSNI have to be calculated. The crucial step for national accountants is to see and accept the difference between analysis on the foundations of economics and economic theories of a higher level.

PM 3. There is a fundamental difference between observing raw data, such as a sales slip, and making imputations e.g. by a simulation model. The function that the current national accountants select for themselves, measurement without (adequate) theory, would have to remain in existence also when eSNI would be included in SNA. Thus the present discussion is not about abolition of that function. Instead, it is a discussion about completeness. A painting with only a single colour would hardly be called a painting. When these are the painters in town then the question is why they don't add another colour to create a true painting.

PM 4. There are also other developments in economic theory that might be seen as being at the foundations. A suggestion from behavioural economics is that agents are no utility maximizers. Apart from the question whether these insights really lead to different foundations they are not discussed here.

PM 5. Analysis at the foundations has e.g. also resulted in behavioural economics that e.g. calls into question whether people are "rational", and additional analysis on "happiness" that e.g. calls into question what our motives and drives are. Conceivably, these approaches may call into question whether Lord Robbins' definition of economics (with the notion of scarcity) is still adequate and similarly whether the neoclassical approach as used by Hueting still is adequate as well. We might draw the analogy with the shift from mercantilism to utility analysis, to indicate what changes might happen at the level of the foundations. However, apart from the question whether such new approaches are really alternative to neoclassical approach, Hueting's foundational analysis remains robust under such alternative approaches (while its statistical counterpart links up to the institutional approach that is also robust in measurement).

2. The period up to "New Scarcity and Economic Growth" 1974

The period up to Hueting's thesis can be seen as advance. Being an economist at the Ministry of Social Affairs, doing labour market research, Hueting discovers the environment around 1965, a period when world population stood at 3 billion. Hueting (1969) introduces the concept of environmental function for an international audience. He writes articles for a Dutch economics magazine ESB and bundles these in "What is nature worth to us?" (in Dutch, 1970). From his first article onwards, Hueting states that the national income (NI) figure is incomplete, as he states it now in Hueting (2008): National income is the sum total of the values added by man. These are added to the non-human made physical surroundings. Producing is adding value. Water, air, soil, species and life support systems are not produced by man. So the physical base of human existence falls by definition outside of national income. Hueting: "Now I am only repeating what I stated around 1965." (Quotes like these are personal communications.) These were the years of Meadows (1972), "The limits to growth".

His articles led to contact with Tinbergen and eventually, also via other contacts, to an invitation by CBS Statistics Netherlands. Hueting: "The intention was that I would start

in the department of National Accounts. However, the head Theo Bouthoorn planned to retire in a few years and did not want new issues in his department. Co-ordinating director Kees Oomens then decided to create a separate department for environmental statistics. In hindsight it might have been better to be part of the NA dept, but anyway we required a base of physical data, and now we had ample opportunity to do so." Tinbergen, Pen and CBS now urged that Hueting put his findings in a thesis. Its genesis was straightforward and it became Hueting (1974) "New Scarcity and Economic Growth. More welfare through less production?". Hueting (also a jazz pianist): "I composed the book as a fugue of 5 voices, economics, ecology, history, social issues, unemployment, all flowing together into in the figure of national income."

3. Some conclusions from "New Scarcity and Economic Growth" 1974

The following quotes indicate some highlights:

"The crucial question 'What is nature worth to us?' cannot be answered by means of the instruments available to us. But in my opinion the study has shown that at the same time another question remains unanswered, namely 'What is the worth to us of goods that are produced and consumed at the expense of the environment?'. For when the value of the environment cannot be determined in the conflict between production and the environment, the market price of produced goods may no longer be accepted as an indicator of the economic value of these goods." (p185)

"Corrections to national income (in order to arrive at a series of figures to place alongside the existing ones) are possible only for losses of function in which the want for the function may be derived from market data." (p186)

"All the information now available suggests that an unchanged continuation of growth of production and of population will almost certainly lead to ecological or climatic disasters or to a collapse of our civilization as a result of the exhaustion of energy and national resources, shortages of food, pollution or lack of space." (p187)

"Environmental deterioration is therefore above all a problem of future generations, for which this generation is responsible. (…) In this situation, which has no precedent in the history of mankind, the level of activities will, in my opinion, have to be limited to such an extent, on the strength of ethical considerations, that the future is given a fair chance." (p187)

"Man's wants are to a considerable extent determined historically and culturally. They are also open to influence to a high degree. (…) If this view is correct, optimism with regard to human happiness is justified, even if the availability of means of satisfying wants decreases." (p188)

"The hope for a livable environment for our children seems best served by optimism regarding human imagination and ingenuity, which are great, and pessimism regarding human institutions, which are slow to react." (p189)

It is important to observe that Hueting's analysis concerns national accounting, no more, no less. There are two elements, one part pure science based upon observed market prices and another part beyond that with the suggestion of an ethical approach with respect to merit and demerit goods. Only the first is included in national income. It is only after more than a decade in 1989 that Hueting arrives at his "what if" approach to

bring sustainability also within the realm of national income. NB. There are authors who interprete the later development of eSNI as reflecting purely a political or ethical choice, and who reject eSNI for this reason. These authors then agree with the Hueting (1974) conclusion that politics and ethics are no part of national income, but they miss out on the Hueting (1989a) analysis on the role of assumptions in national accounting and the "what if" approach designed after 1974.

4. Reception of "New Scarcity and Economic Growth"

4.1 On the positive side

"The thesis was received with hosannas," Hueting recollects. The hall where he defended his thesis was overcrowded, he received a Cum Laude, later he presented a copy to the Minister of the Environment Irene Vorrink with the national press present, there was an invitation to the Royal Palace where he presented a copy to Prince Bernhard, and over the next year 5000 copies were sold – which is a sizable number for a small country.

This reception reminds one, see Turner (2005), of the reception in Britain of David Pearce's "Blueprint for a green economy" in 1989 – also a UN Global 500 Award winner.

4.2 Six year delay in the publication of the English translation

4.2.1 Manuscript sold to a U.K. publisher

The connection to Prince Bernhard appeared valuable since he was the first president of the World Wildlife Fund, later renamed World Wide Fund for Nature, and WWF International financed the English translation of the thesis. The translator Trevor Preston had worked parallel with Hueting so the English version was available a few months after the Dutch version. Sadly, its actual publication was delayed to 1980, for reasons that remain obscure to this day. Elsevier sold the manuscript to Liverpool University Press, for unclear reasons. The editor there had all kinds of objections and didn't do much. The ordeal lasted six years and it required an intervention by Tinbergen, the Minister of Economic Affairs Hargert Langman, the Minister of Environment Roelof Kruisinga and others, to resolve it. A letter went out to Elsevier stating that the publication was a "case of national interest", Elseviers bought the manuscript back, and it was published within a few months, in 1980. "The delayed publication was a major setback," Hueting observes. "I had become a member of various international committees and without the backing of the book people could not understand my argumentation or could not consider it with proper attention. There was no base for discussion and understanding. The book missed the international impact that it could have had. By the time that it became available, there were already other approaches by others that distract from the argument."

4.2.2 Mishan's reaction of "nothing new"

In the ordeal with Liverpool University Press, the editor produced a letter from E.J. Mishan whom he had invited to review Hueting's manuscript. Mishan appeared to give a very negative review, stating that Hueting's book contained "nothing new". Hueting rejects that statement and suspects that Mishan did not enjoy his remarks on K.W. Kapp (1950) whom Hueting considers much more comprehensive than Mishan (1967). On Mishan's book Hueting (1974, 1980:75) states: "As in the case of Kapp – who, strangely

enough is not mentioned, any more than Boulding is – the effects on the environment form only a part of the adverse effects of the growth of production discussed. (…) Mishan includes (…) also the influence on our cultural pattern. The later facet, where, in my opinion, he arrives at a number of highly disputable conclusions, will not be discussed here."

The UN, EU, IMF and OECD (2003) Handbook on Integrated Environmental and Economic Accounting (SEEA 2003), Section 10 paragraph 199 reads:

> "Much of the initiative to look for an alternative path for the economy rather than a different measure of the existing economy came from the work of Hueting in the late 1960's and early 1970's. He introduced the concept of environmental function referred to throughout this manual, explaining how pressure on functions leads to scarcity or competition for these functions. As with any economic good or service, this scarcity gives rise to an economic value due to the opportunity costs involved in their use or appropriation."

Mishan's judgement thus was too quick. Given Mishan's important position in the field at that time this was also a major set-back.

4.3 No adoption of the key proposal

Despite the enthusiastic reception of the book in Holland, the key proposal in it – i.e. to create a corrected figure alongside the official figure for national income – was not adopted, neither by policy makers nor by CBS Statistics Netherlands itself. Hueting identifies two causes: "One cause lies with myself. The result of the thesis was that the environment could only be valued partially, for the reason that the preferences express themselves in the market only partially. They show only by expenditures on elimination and compensation, or what I now call the "asymmetric entries". I was afraid for the "pars pro toto effect", i.e. that if a corrected figure was published then people might think that it would be sufficient to consider only this figure. I was leaning to the idea that at least the thesis showed that while there was no figure available for the scarcity of the environment, this also meant that the NI figure is incorrect." The other cause lies on the receiving end. Hueting: "My colleagues at the department of National Accounts didn't see a reason for change. I myself didn't exert as much force as I might have, because of the "pars pro toto effect". The CBS directorate has always been in favour of my research but neither saw a reason to go against the will of the Department of National Accounts."

Now retired CBS Director and former head of the Department of National Accounts H.K. van Tuinen states in Van Tuinen (1975), in reaction to Hueting and apparently independently, the "pars pro toto" effect as well. He refers to difficulties in empirical applications of welfare economics, therefore rejects adaptation of national income but mentions that environmental functions could be included in a satellite module to the national accounts.

A critical impression by me is that it seems that Hueting was also surprised that his strong and coherent exposition apparently was not convincing by itself – and that he did not know what else to say. We will return to this in section 6.

5. The period up to the Brundtland report 1987

5.1 SNI and eSNI

In 1986 Hueting already applies physical standards, yet the theoretical presentation of the "vertical demand curve" appears for the first time in 1989. He uses the term "sustainable national income" but the literature starts to abound with so many different concepts of sustainability, that in 2007 he adds a prefix for the proper kind of sustainability: "(environmentally) sustainable national income" (eSNI). For a discussion of the various measures arising over time, see Hueting (2001a) "Parable of the carpenter", Hueting's (2001b) "Rejoinders" and Hueting and Reijnders (2004).

5.2 The notion of (environmentally) Sustainable National Income (eSNI)

In the period since his 1974 thesis, Hueting develops the Dutch environmental statistics, participates in international committees, and writes papers on how to practically resolve the insoluble issue of valuing nature. In 1983, the U.N. General Assembly passed a resolution, speaking about "sustainable development", and established the World Commission on Environment and Development also known as the Brundtland Commission. In 1987 it published the report "Our common future". In this period, Hueting came to realize that the political choice for sustainability actually was an expression of a preference. What was hitherto unknown and unobserved, now became tangible, and what seemed insoluble up to then suddenly came to a solution. This led to the Hueting approach to represent the assumption of preferences for sustainability by a vertical line, based upon a physical standard which expresses the sustainable burden on the environment – see also Daly (2001). This approach thus includes the conditional or "what if" calculation: *If* you want sustainability *then* this gives a figure for "(environmentally) sustainable national income" (eSNI).

Goodland (2001:320) discusses the events:

> "In 1983, UNEP, led by Yusuf Ahmad, convened the first international workshop to explore how sustainable national income should be calculated within the whole UN system by modification of traditional SNA. I supported this new and potentially powerful approach and managed later to bring in Salah El Serafy who led the World Bank into Green Accounting. As Hueting was the only person in the world to have been working on adapting the accounts of any nation up to that point, he contributed greatly to what became known as the "UNEP-World Bank Working Group on Environmental Accounting". The World Bank hosted the second workshop in Washington in 1984, OECD a third workshop in Paris in 1985, and again in Washington in 1986, by which time Environmental Accounting had become institutionalized. This group focused mainly on incorporating the exhaustion and depletion of environment and natural resources in national income, notably in developing countries. (…) The results were published in 1989 in "Environmental Accounting for Sustainable Development". Progress on Environmental Accounting then slowed down from the early 1990s until the present, and the World Bank Group still relies more on unadjusted national accounts which exclude environmental losses."

Goodland (2001:320) also records where Hueting's approach originated:

> "Much of Hueting's work originated in developing countries. After having worked on sustainable national income for the Netherlands, Hueting extended his approach to Indonesia. His proposal to approach sustainability for environmental functions was first made during his visit to Jakarta in 1986, on invitation of H.E. Emil Salim, Minister of Population and Environment (Hueting, 1986b). Hueting then broadened his approach while on the team that produced the "Taiwan 2000" study."

5.3 Hueting on the Brundtland report

Hueting's 1988 paper, presented in New Dehli, rejects the Brundtland report since it combines sustainability with conventional growth of production, while proper sustainability cannot be attained in such manner.

The Baumol effect has the emblemic example that a Beethoven string quartet requires the same input now as 200 years ago. The shift in the economy from agriculture to industry to services had already been observed by Sir William Petty, and has recently been documented in the World Bank (2000) "Beyond economic growth". However, the "Hueting effect", if one may call it that, is that the greater part of productivity growth by far is generated by precisely those activities that burden the environment most, see Hueting (1981ab). The core of productivity growth is generated by the agricultural and industrial base, and this explains the impact of "economic growth" on the environment. Hueting prefers "production growth" for the relative change in NI since economic welfare would be much wider. Production growth tends to reduce sustainability, while growth in economic welfare would probably benefit from reallocating activities (that reduce NI growth).

6. The period up to the Hueting Congress 1999

6.1 Tinbergen & Hueting 1991

In an important step, Hueting maintains the support by Jan Tinbergen. In a joint article, Tinbergen & Hueting (1991) for the World Summit on Sustainable Development (WSSD) in Rio 1992 present the Hueting approach of the "what if" calculation by eSNI:

> "Standard setting was also considered, but the questions of what standards were to be set by whom could not be answered at that time. This situation has now changed. Especially after the 1987 Brundtland Report, politicians and organizations worldwide declared themselves in favour of sustainable use of the environment. This preference, voiced by society, opens up the possibility of basing a calculation on standards for sustainable use of environmental functions instead of (unknown) individual preferences. Therefore, the following procedure is proposed for correcting GNP for environmental losses (Hueting 1986, 1989)."

The authors arrive at a rough estimate that world eSNI is about 50% of world income, which estimate is corroborated by later findings.

6.2 CBS and CPB

In Holland, there exists a historical specialization of tasks between CBS Statistics Netherlands that provides the statistics, necessarily for the past, and the Central Planning Bureau (CPB) that provides projections for policy making, necessarily for the future.

Tinbergen actually helped create that distinction by moving his planning section from CBS to create the new CPB in 1945, just after WW II. Hueting worked at CBS and the author has worked at CPB.

Hueting's position at CBS has always suffered from the fact that "future generations" sounds like "the future" and not "the past". The generation currently alive has an influence with regards to future generations and thus by necessity has a paternalistic preference, for good or for bad. Those future generations aren't present yet and cannot express their preferences. Using that paternalistic preference we can consistently define "sustainability" using only the current generation. However, some authors don't seem to understand this and they consider it confusing that a statistical bureau would investigate preferences of future generations. eSNI however relies on assumptions on individual preferences of those currently alive.

In the Dutch set-up, Hueting's concept seemed to run opposite to the two different institutional paradigms. Perhaps he should have moved from CBS to CPB, to project sustainable paths for the future and include some "base values" for the past as a side product. As it happened CPB did not understand or agree with Huetings approach anyway. Various economists at CPB comprehend the notions of national accounting, but not all people at CPB understand all of it. At CBS Hueting had ample contact with colleagues and there was more scope for discussion but with CPB these moments were essentially limited. Around 1983 the CPB abolished its own section on the environment (Passenier (1994:298)) while Hans den Hartog, member of the CPB directorate and a good contact for Hueting, suddenly died in 1992, at 58 years of age. Hueting and Den Hartog worked together on the first publications by CBS and CPB on the environment, see CBS (1972) and CPB (1972). The long run study CPB (1992) for 1990-2015 also considers the environment.

The Hueting et al. (1992) methodology for the calculation of SNI basically uses statistical averages for the estimate. This met with criticism that behaviour would be affected by sustainability measures and price changes, and that this required a model. Though CBS already had a model created by Wouter Keller, the CPB claimed that model making was its province as well and that CBS should stay out of that realm.

The dispute between CBS and CPB was strong. (a) In 1993, there was an incident concerning an article by Hueting for economics magazine ESB. (b) In 1996, the Minister of the Environment Margreeth de Boer and Minister of Economic Affairs Hans Wijers were misinformed by some of their officials about eSNI, leading to a misinformation of Parliament. (c) When a meeting between Wijers and Hueting resolved this, CPB claimed its monopoly at making models and succeeded in getting Wijers and the CBS to accept this. A separate project was created with a special subsidy to calculate eSNI, joining CBS, environmental institute RIVM and university group IVM. This group actually used the Keller model but a consequence was that eSNI was moved out of CBS. Also, Hueting now had to clarify the entire issue and the principles of national accounting to the people at IVM, both Frank den Butter as chairmain of the overseeing committee and Harmen Verbruggen and the other members in the actual research group.

In this process, internal doubts at CBS were key. The setup for eSNI was only on paper, it was experimental and based upon new theory. A first rough calculation was done by the National Accounts Dept. with an input-output model, but, still, it was experimental. At CBS itself, some rejected the use of a model as well. The directorate of CBS did not wish to rock the boat and required general support, which it did not get. In a way the

criticism that a model would be required may have been a blessing in disguise since eventually that model was created, increasing the robustness of the measure. The Dutch institutional deadlock was worked around and the number of people involved was enlarged. Nevertheless, had there been international support then the directorate of CBS might have taken a stronger position. Below, we will first consider the internal discussion at CBS and then look at the international situation.

6.3 Inside CBS Statistics Netherlands 1991-1999

In 1994 Hueting reaches the age of 65 and retires from CBS but maintains his office and in practice works like before. Jan Tinbergen also passed away in 1994, at 91 years of age, so could no longer support Hueting. In the years around Hueting's retirement, the then head of the Department of National Accounts Steven Keuning (currently Director General Statistics at the European Central Bank) formulates a more conventional view on the national accounts and the environment, Keuning (1992), finds support for this with the CBS directorate, and thus effectively creates the CBS position that differs from Hueting's position. The statistics generated by Hueting's Department of Environmental Statistics are translated into satellite accounts, similar to the social accounting matrices in the Keuning (1995) Ph. D. thesis. The transformation is done under joint responsibility of Hueting and Keuning. Keuning also participates in the London Group of the U.N. Statistics Division (www.unstat.org) that is instrumental in national accounting and the environment. A reference for this period is De Haan and Keuning (1996) on the NAMEA. De Haan is the current chairman of the London Group. When the London Group meets on occasion at CBS in Voorburg, Hueting is not invited to participate, causing the spectacle of different paradigms working on different floors. The author and Keuning were fellow students in the 1973 enrollment class in econometrics at the University of Groningen and the reader should take into account that relations have always been friendly.

6.3.1 The onset of SEEA

The work done at CBS Statistics Netherlands appears to have had an impact on international environmental economic accounting. Looking back in 2006, Robert Smith (2006) reports on the SEEA 2003:

> "The preparation of the System of Environmental and Economic Accounts 2003 marks an important milestone in the world of official statistics. Just as the development of the original guidelines for national accounting in the 1950s was the first step toward today's robust, internationally comparable economic statistics, the System of Environmental and Economic Accounts 2003 offers hope to bring order and comparability to environmental statistics."

Currently, UNStat has installed the Committee of Experts on Environmental Accounting (UNCEEA) to guide SEEA to the same status as SNA and to oversee implementation.

Both eSNI and NAMEA are part of SEEA 2003. Hecht (2007:7-8) in her short historical review correctly observes:

> "The Netherlands was also a leader in the development and adoption of environmental accounting. Dutch interest in this area originated with the work of Roefie Hueting, who developed and sought to implement a measure of sustainable national income that would take into account the degradation and depletion of environmental assets resulting from economic activity. Although

his approach was not implemented at that time, his work led the national income accountants to develop the national accounts matrix including environmental accounts (NAMEA), which builds on portions of the national income accounts by adding physical data on pollutant emissions by sector. The NAMEA approach has been adopted by Eurostat, implemented in many other European countries, and integrated into the environmental accounting procedures developed under developing it several decades earlier. (…) Despite its limitations, it is a valuable framework for organizing economic data about the environment, and is an essential input into the analyses desired by economists and environmentalists."

6.3.2 eSNI and NAMEA

The key point to observe is that Dr. Hueting apparently did not succeed in convincing his younger colleague Dr. Keuning of the value of eSNI so that Keuning preferred NAMEA. *The Economist* (1998) reported:

> "Steven Keuning, head of the Dutch national accounts department, points out that the entire attempt to attach cash values to environmental goods and bads is a bit nonsensical. The reason is that, had the environment been priced in the way that statisticians might value it, people would have behaved differently. The valuation exercise, he says, postulates a situation that could never have existed. (…) The lobby for crafting separate environmental measures that avoid monetary valuations has been bolstered by Eurostat's copious research money, and by Mr Keuning's impressive presentational skills. The lobby for green GDP and valuation has its headquarters in the World Bank, and draws its main support from developing countries and from environmentalists."

The newspaper opposes NAMEA to environmentalists at the World Bank and seems to neglect, perhaps not in background research but at least in its publication, the alternative of eSNI present at CBS itself. Hueting rejects the quote that eSNI is a "valuation exercise". Also, he agrees that eSNI is fictitious, and based upon a model, but emphasizes that NI is fictitious as well. NI is only informative if you postulate that there is no "broadness" and that there are no preferences for sustainability (which leaves you to explain that governments express such preferences but perhaps don't really mean to).

Stauvermann (2006) agrees with Keuning's point of view:

> "The exercise should be carried out if the public is interested in such numbers, but it should not be published by statistical bureaus, because one important characteristic of the SNA is, that its numbers are not based on ideologies and political ideas. (…) This conclusion coincides with the decision of the CBS regarding the question how to account for the environment. Nowadays the NAMEA is part of the official statistics of the Netherlands and the SNI was rejected as an accounting tool. The SNI was calculated by the IVM (Free University of Amsterdam) as a political indicator. In some sense the developments regarding green accounting on the Dutch and international level were very similar. In the Netherlands a commission of economists was founded to decide about the most preferable accounting system. On the international level the London Group, which consists of national accountants from different countries, was selected to solve the same problem. Both groups came to the result that it is preferable to adopt the NAMEA instead of a GNI or SNI."

Addendum: In an email to Hueting in 2009, Stauvermann corrects this statement and states that he adopts Hueting's position.

Note that Keuning participated in the CBS decision and in Eurostat and in the London Group. It may be that international participants let themselves be guided by Keuning's view on eSNI instead of studying the original author. His arguments won the day, in succession at CBS and the London Group (though need not be convincing to us). Stauvermann neglects that both NI and eSNI are based upon assumptions and both are "what if" figures, and that both are equally non-political.

6.3.3 What is not generally known

Hueting takes a different position. At a conference in The Hague, he openly expressed his annoyance at some manipulation and censorship:

> "Steven Keuning, (…) as head of the Department of National Accounts of the CBS, has written a number of articles where he first presented eSNI in a wrong manner and then attacked it, whereby he arrives at sometimes bizarre conclusions that turn the case upside down. One of those articles appeared in the CBS book "The value added of the national accounts". I have refuted the arguments by Keuning and some other authors for the CBS *Liber Amicorum* for Henk van Tuinen (…). That article has been refused without stating a reason, an event without precedent that boils down to censorship. That article is now (…on the internet [Hueting (2003)]…)." Hueting (2006)

A newspaper report by Robles (1997) gives an excellent review of the period, for Dutch readers, but does not mention those details.

6.3.4 The key question

Let us return to the question whether a national statistical office or the United Nations SNA "should" include eSNI alongside NI. Hueting has expressed his judgement that the trident of NI, NI minus asyms and eSNI (see **Table 3**) are best published by the national statistical office, but has agreed, in practice, since it would not have been feasible otherwise, that eSNI was calculated in a project group outside of CBS but with help of CBS. A joint presentation of all figures might only happen though if they are provided by the same institute. Recently, the Dutch national government planning department for the environment MNP reported in the same edition both that the environmental pressure had been reduced and that the gap between NI and eSNI had increased – see MNP (2006) – so it seems that they don't understand eSNI. Thus, it remains useful to consider the arguments that originally caused Hueting to regard eSNI as part of the system of national accounts (SNA).

Consideration of these arguments causes an element of repetition. In **Figure 6** and **Table 3** and the discussion around them, this article already summarized the various relevant angles, and hence one might suspect or hope that the argument would be crystal clear by now. The argument can also be enlivened by referring to the proverbial lemmings. When lemmings run into the sea and drown by thousands, scientists can record how many steps are taken and in what direction, and they can measure the distance and time to the sea, without any qualms that such measurements would reflect a political choice in any way. Such measurements neither imply that the lemmings, arriving at the edge of the sea, will indeed get into the water. Scientists can calculate a probability for how many will cross a line and tumble in. However, when it concerns mankind veering off the sustainable path,

these scientists seem to lose their composure. They only measure steps and refuse to calculate the distance and time to the sea. The true cause may be that they are not quite open to the ecological conclusion, are not located in the zone of co-operation, and thus really don't see the sea, and are not reliably aware of the problem. Under what conditions will they open up to the scientific findings of ecologists ?

This question can be reformulated: what does it *mean* to national accountants that the calculated figure of eSNI is about 50% of NI and that the absolute gap is widening ?

In the introduction we saw that national accountants have insulated themselves against these questions. In their view there is a core of accounts that is available for all theories and there are modules depending upon the user. Their approach is institutional and not analytically bound to any particular economic theory. Sustainability is just one possible application. We also discussed that this approach neglects that sustainability applies at the foundations of economics so that the statistical approach is not sensitive to levels of discussion (see section 1.6). The following arguments have to be evaluated at the level of the foundations of economics and it is not adequate to respond to them with arguments concerning higher level economic theories.

With the advantages and disadvantages of repetition:

(1) **Objectivity.** The eSNI figure (sales slips plus model) is as objective as NI (sales slips only). It requires a model but that can be realistic and reflect the state of the art in econometrics. eSNI is not a number based upon ideologies and political ideas but derives from the objective notion of environmental sustainability. eSNI provides information about a possible policy objective that is widely being discussed and can be found in official statements. The only "force" exerted is by such statements and not by the information provided by eSNI.

(2) **Uncertainty.** Environmental issues and the state of preferences are clouded with uncertainty. Economics has ways to deal with uncertainty – which is the crux of what our science contributes to decision making. For example, the Central Planning Bureau (1992) study for the period 1990-2015 gave scenario's for possible developments. It is not uncommon but actually standard that economic studies deal with large uncertainties. The distinction between NI and eSNI is a way to tackle large uncertainties. It would be curious to reject eSNI because of uncertainties involved while neglecting the interpretative uncertainties around NI.

(3) **Social welfare.** Because of a lack of a demand curve the shadow prices of the environmental functions cannot be determined. This means that the correct prices for commodities that are produced and consumed at the expense of those functions are equally unknown – while standard national income presupposes such prices. This information deficit can only be solved by making assumptions about the relative preferences. One of the many possible assumptions is that the agents have a preference for sustainability. Another possible assumption is that the economy now is on an optimal path. Under the assumption of current optimality the observed market prices are correct, and under the assumption of preferences for sustainability the prices of eSNI are correct. Since we don't know what the real preferences are it follows that the social welfare interpretation of eSNI is as fictitious as the interpretation of NI. For NI we don't need a model but NI still is only interesting because in the traditional view it approximates social welfare or in the broad view forms a factor for it. Otherwise it would not make much sense to split the nominal tax data into price and quantity components. But if NI is thought to relate to

preferences, and if society has expressed a preference for sustainability, but NI does not express sustainability, then SNA cannot maintain that this NI figure really represents what it intends to measure, and the whole exercise becomes pointless. Thus, the economists involved in national accounting might rather hand back their jobs to the government, reporting that the government is giving inconsistent signals if it states that sustainability is in the SWF but it does not really act on that.

(4) **Scientific assumptions.** Both NI and eSNI depend upon assumptions. Economists Tinbergen, Samuelson, Kuznets, Hicks, Meade and Stone created an edifice of national accounting that now employs millions of people (including those working at companies sending their data to the national accounting offices) which edifice was based upon assumptions, but those assumptions may no longer apply nowadays. National accounting has turned into some ritual, with little meaning since society has become rather schizophrenic on its preferences. The national accounts have become "measurement without theory", which may be fine at the operational level, but is a distinct loss for economic science and our understanding of the world.

(5) **Information.** Many governments have expressed an interest in environmental sustainability. But they have not instructed the statistical bureau's to calculate an eSNI. To what extent can a scientist "understand" the situation and become "pro-active" ? A key point is risk. Sustainability itself involves a notion of risk and it is measured with uncertainty. There is a role for science here. Conditionality ("what if") is a way to deal with risk. At least one economist involved in national accounting indeed decided to do some calculations. Nothing in Hueting's work "forces" society to choose for sustainability. This was decent scientific work, and nothing should stop other scientists from proceeding in the same manner. Alternatively, scientists can lack interest in studying this subject and then let politicians decide in darkness without the proper information. Then perhaps Parliaments should resolve the issue by explicitly instructing national statistical bureau's to include eSNI alongside NI. Anyhow, we can acknowledge that there is room for scientific interest and responsibility.

6.3.5 The CBS rejection of eSNI

It is useful to reconsider some papers produced at CBS Statistics Netherlands in the light of Hueting's 2006 remark on maltreatment.

6.3.5.1 Van Tuinen

Now retired CBS Director and former head of the Department of National Accounts H.K. van Tuinen has written on some occasions. We have already referred to Van Tuinen (1975). Van Tuinen (1993:26-27) summarizes the same position. Apparently he does not react to the shift in Hueting's position with the invention of the vertical demand curve. He recognizes that Hueting writes from a welfare economics point of view but does not react to the implications for the foundations of economic analysis and economic statistics. Emphasis in the article is on the '(dominant) Dutch view'. His opening statement (p13) "The original aim of national accounts (NA) is to present timely and reliable indicators on the performance of the economy" might suggest that a definition of "performance" might be possible outside of welfare economics. There is reference to work by Keuning but no criticism of it. Van Tuinen (2008:22) is more extensive on welfare economics and states: "the involvement of official statistics in developing and estimating the SNI is a recommended element in the above mentioned strategy". Hueting

has received support by Van Tuinen over the years but apparently it has not been possible to maintain eSNI within CBS Statistics Netherlands.

In an email to Hueting, Van Tuinen writes in October 2007:

> "In my paper for the OECD-conference (background paper for the session on official statistical offices) I strongly recommended official statistics to initiate and stay involved in estimating the eSNI because I am convinced that the economic concept of the eSNI is theoretically sound and policymakers and society are in urgent need of this indicator which shows how much the current economic development differs from a sustainable path. The fundamental assumption underlying the eSNI is that economic subjects have a preference for sustainability and the eSNI shows the level of NI attainable applying current technology within the constraint of sustainability. The presentation of data on eSNI alongside those of standard NI must inspire policymakers to develop strategies which effectively decrease the distance between both variables. These strategies can be targeted to the level and composition of standard NI as well as to technological innovation which increases the level of future eSNI. Therefore, the function of eSNI is limited to present information for evidence based policymaking. The eSNI itself does not set a target but it helps policymakers in developing targets for their strategies."

6.3.5.2 Keuning

One of the considerations by Keuning (1992:9) is:

> "Contrary to the de-facto measurement which is applied in conventional national accounts, the construction of an adjusted NDP or National Income is *not accounting but modelbuilding*. [Footnote: This was the core of Eurostat's comments on an early draft of the section on environmental accounting in the next SNA. (…). End footnote.] If the (substantial) costs substracted in these approaches had been charged in reality, we would have lived in a totally different world and it is quite naive to assume that all economic subjects would have swallowed these costs without an adjustment of their behaviour. In fact, environmentalists often argue for certain protection measures just because of their dynamic substitution and supply effects. This implies, obviously that the negative effects of such measures on NDP are probably less than the simple computations of "Eco-Domestic Product" or "sustainable national income" would suggest. (…) Anyhow, these consequences can only be approximated with the help of a formal model. Replacing GDP by a figure which is an erratic combination of a statistic and the outcome of an (implicit) model thus amounts to throwing out the baby with the bath-water."

These considerations restate the basic specialization of jobs between CBS and CPB. They can be evaluated in the following way, again at risk of repetition:

(i) See the five points mentioned above.

(ii) At any moment in the past, the economy is sustainable or not. At issue is to measure that situation in the past. This gives an account of where society would have preferred to have been, given the assumed preference for sustainability.

(iii) Use of a model is not in itself "wrong". When the CPB gives a projection for the next year, with a model that represents the best insights at this moment, then that

model with its relationships might also be used for assumed behaviour in a past year.

(iv) There can be uncertainty about the assumptions required to properly estimate sustainability but those can be handled. It is feasible to include eSNI in SNA.

(v) It is *accounting* to record that the model (a) is state of the art, (b) reproduces NI, (c) produces eSNI when sustainability is imposed.

(vi) In the model, behaviour indeed changes to arrive at sustainability. That namely is the purpose. But as such it does not invalidate the estimate for sustainability.

(vii) The distance between NI and eSNI of necessity is a simple substraction, but that does not imply that the model is that simple.

(viii) While NI is directly observed in the sense of counting sales slips, eSNI as a model based figure is still a "statistic" in the mathematical statistical sense of the word. A doctor can directly listen to a chest, which is lean on theory, and a CT scan involves much more theory, but both methods would still be considered "observation", since there is no implication that the patient "should stop smoking". The combination of NI and eSNI is not in itself "erratic" and does not imply "throwing out the baby with the bath-water" but actually supplements information. The eSNI figure will still be based upon the environmental data collected by CBS, subsequently upon the NAMEA based upon those, if that is regarded as the baby.

(ix) This discussion suffers from connotations related to the term "(national) accounting". In one realm of our life we wish to see accountants who only record data, like processing sales slips for example. It is important to have that record. In the present discussion this function however detracts from the focus. At issue is the *intention* of the term and the body of economic theory behind it. In traditional economics NI is intended as a proxy to social welfare, and the theoretical emphasis is on welfare and not on national income seen as the net result of those sales slips.

Hueting (2003) states, in a paper intended for the *Liber Amicorum* for Henk van Tuinen but that thus was censored for that publication (see the quote in section 6.3.3 above):

> "Steven Keuning gives in his contribution to the CBS book "The Value Added of National Accounting" [1993] first a completely wrong review of eSNI. Upon this he subsequently bases six objections that all six are off the mark. But the most bizarre objection is: "This may lead to misleading policies: in the event of enormous damage which can be prevented or restored inexpensively, one is not encouraged to apply this measure precisely because it does little to improve 'green income'." In that one sentence Steven overlooks three essential aspects of eSNI. (i) The measures are arranged by increasing cost per unit avoided environmental burden (…). (ii) Whether environmental damage is enormous is determined by the preferences (…) From this it follows (iii): the lower the costs the higher (not the lower) the eSNI, the smaller (not the larger) the distance to sustainability and the bigger (not the smaller) the encouragement to take a measure." Hueting (2003)

A key article for a wider audience is Keuning (1996). Based upon this article, a Member of Parliament, Ferd Crone, stated in Parliament that an eSNI is impossible. When

Hueting contacted Crone and asked why, he replied: "But the article was by someone of CBS, so I presumed that you agreed." This reaction is imprecise since the Keuning article explicitly states that it was written as a personal opinion. Eventually, the misunderstanding was ironed out and Parliament, including Crone, supported a subsidy for the calculation of eSNI. Yet, somehow, possibly by this course of events, the optimal solution that eSNI would be calculated by CBS, became unattainable.

6.3.6 A costly choice

The internal CBS process can currently only be seen from the vantage point of today, for example with the availability of the Van Ierland et al. (2001) book. The statistics developed by Hueting, as head of the CBS environmental department, and the NAMEA based on those, eventually have appeared to be important for the development of international statistics on the environment, SEEA 2003. eSNI still has to follow. The statements by Keuning do not differ from so many other international authors. Admittedly, international statisticians might have relied on Keuning's reports on eSNI rather than consulting the original work by Hueting, just like The Economist newspaper, cited above.

When the 1999 Hueting Congress was held, Hueting (2003) recalls: "Steven congratulated me (…) and said: "We don't differ in theory but in politics." To this day I still do not understand what he meant by that." To the present author it suggests that Keuning thought that eSNI was based upon political choice and that he wanted to keep it out of CBS Statistics Netherlands. Above we saw that Keuning missed some points in Hueting's analysis but this of course still allows him to think that he didn't miss anything. The argumentation provided by Hueting has convinced the present author that eSNI actually is not a political choice but a conditional statistical figure, just like NI is conditional to its assumptions. Yet, it is difficult for one scientist to decide that another scientist ought to be convinced as well. It is not uncommon in science that theorists working on the same subject have strongly different approaches while onlookers cannot understand why that is so.

Figure 6 clarifies the misunderstanding. It is tempting to diagnose Keuning as a "majority economist" less "open to the ecology", and not located in the "zone of co-operation". However, Keuning, like Hueting, works in the core of economics, studies social welfare (SESAME) and national accounting, and, with NAMEA, he clearly is open to issues of ecology. To catch the distinctions we need some subgroups. We can distinguish two dichotomies. First of those who support or do not support eSNI. Secondly of those who accept or do not accept its theory. Hueting is in core subgroup 1, Keuning is in core subgroup 2 who does not support eSNI and does not accept its theory. Retired CBS Director and former head of the Department of National Accounts Van Tuinen (1975, 1993, 2008) supports research on eSNI but does not accept its theory since he adheres to the '(dominant) Dutch view' of seeing eSNI as an application and not as a reorientation at the foundations of economics. **Figure 6** importantly helps to clarify that the following question may be key. Hueting is not only "open to the ecology" but also "open to the risk of ecological collapse". Hueting (1974, 1980) refers to the finding by E.P. Odum that ecological collapse cannot be predicted and can be observed only when it is too late. This causes Hueting's essential insight that national accounting in our times has become an issue of risk information management. It may well be that his colleagues were not open to this very point and still leaned to a belief in "economic growth". In other words, for economists in general, the key question becomes whether they are open

to the current ecological risk. As explained in the introduction, this notion of 'being open to the ecological risk' is tantamount to 'being open to adjustment of the foundations of economics' and is tantamount to, at least for national accountants, 'being open to adjustment of the core of national accounts'.

Since the original design of eSNI, 15 years have passed. The historical circumstances are such that a period of 15 years mean an increase in world population of 1 billion. It is unfortunate that there has been a delay of that duration with eSNI. But of course, there already was the Tinbergen & Hueting (1991) article that governments could have reacted to, perhaps the NAMEA was the best approach anyway to start with internationally, and, we must also consider the role of the "ecological economists".

6.4 eSNI and ecological economics

Hueting worked primarily in the community of economic statistics and national accounts, at CBS Statistics Netherlands and the international conferences related to these. He opened CBS Statistics Netherlands to the physical and ecological sciences because of the prerequisites of sound environmental statistics. His contacts with academia and the journals were limited and his outlook was not of an academic writing for journals. The economic journals may have been less interested in his topic of integrating the environment into the national accounts. Events brought Hueting in contact with birds of different feathers, which eventually became a community of researchers around the journal *Ecological Economics,* which published a major series of Hueting's work. [5] Røpke (2004:310): "Most of the precursors were inspired by thermodynamics to rethink both natural and social processes in new terms". These researchers were not necessarily trained in economics and even less trained in national accounting. To this amalgam of researchers, Hueting must have been as different a bird as to common economists.

Costanza (2003), in his short review of the "early history of ecological economics", mentions Hueting, but Røpke (2004), who amplifies this history and who interviewed Costanza amongst others, does not refer to Hueting's work and contribution to the field

[5] For reference, the following statements have been copied from the April 30 2008 website of the International Society for Ecological Economics (ISEE) at http://www.ecoeco.org/index.php
(a) "To promote understanding between economists and ecologists in the development of a sustainable world." (b) "ISEE is a not-for-profit, member-governed, organization dedicated to advancing understanding of the relationships among ecological, social, and economic systems for the mutual well-being of nature and people." (c) "Ecological economics exists because a hundred years of disciplinary specialization in scientific inquiry has left us unable to understand or to manage the interactions between the human and environmental components of our world. While none would dispute the insights that disciplinary specialization has brought, many now recognize that it has also turned out to be our Achilles heel. In an interconnected evolving world, reductionist science has pushed out the envelope of knowledge in many different directions, but it has left us bereft of ideas as to how to formulate and solve problems that stem from the interactions between humans and the natural world. How is human behaviour connected to changes in hydrological, nutrient or carbon cycles? What are the feedbacks between the social and natural systems, and how do these influence the services we get from ecosystems? Ecological economics as a field attempts to answer questions such as these."

of "ecological economics". Costanza et al. (2004) in a citation analysis don't mention Hueting. From the cited works 92 were selected by Costanza et al. based upon personal judgement of what was influential. Apparently, Hueting's publications have had little effect in this community.

In contrast to this, Costanza et al. (1997), "The value of the world's ecosystem services and natural capital", an article in the journal *Nature,* caught the fancy of the time, with citations in daily newspapers around the globe, and indeed with hundreds of citations in *Ecological Economics*. That journal spent a separate edition to reactions. Included there are important criticisms by trained economists Hueting et al. (1998) and El Serafy (1998). Leaving those aside for a moment, it is important, for reference, to restate the strong criticism by Pearce: (1998):

> "(…) the article by Costanza and his coauthors is deeply flawed. (…) Economists' frustration at seeing their contributions abused is therefore understandable. Getting it right has to matter. While *Nature* and the authors of the "value of everything" have got the publicity they quite reasonably sought, they have done so at the cost of some damage to the integrity of the science they attempted to use."

This criticism is repeated by Pearce, Hamilton and Atkinson (2001):

> "The most celebrated recent study that tries to value global ecosystem functions is that by Costanza et al. (1997)." (p213) "Essentially, a methodology developed for valuation at the margin has been applied to a context where it is not applicable." (p215) "It follows that there is no economic interpretation of virtually all the aggregate numbers in Costanza et al. (1997)." (p215).

The criticism by El Serafy (1998:26) is that the *Nature* article uses both "environmental services" and "environmental functions" as separate terms, while these actually are the same:

> "On the evidence of the language (…), and in the light of the environmental literature, one might venture the guess that the authors' service is really a function, and their function is really a service (…) Such an interpretation would conform with the standard (Hueting, 1980) definition of an environmental function (…) Hueting is nowhere mentioned in the article, nor his terminology followed."

Thus the "ecological economists" are not quite "economists". While Hueting has done his best to incorporate other sciences in his work – i.e. to use as the data to proceed with – it appears that Costanza missed out on the basics of economics and national accounting. For reference, professor Costanza started out with an MA in architecture and urban planning and had his Ph. D. in systems ecology with a minor in economics. Seen from this angle, this research community on their part has failed in synthesizing economics and ecological science, hence "ecological economics" is only a label but not necessarily convincing in content. One would wish that their studies would have been more directed towards economics. Note that the two disciplines of ecology and national accounting are not competitive but co-supportive, as different dimensions rather than opposites. Hence, both angles are important. The best approach is to express both ideas. Nevertheless, the difference in approach between Costanza and Hueting was not reported in *Nature*.

Hueting recalls a workshop "Valuation Methods for Green National Accounting: a Practical Guide", organized by The World Bank, the U.N. Statistical Office and the journal *Ecological Economics*, in Washington, D.C., March 1996. There Hueting presented his "Parable of the carpenter":

> "But I am worried about the existence of more than ten different methods in the literature of ecological economics for the valuation of environmental losses, with outcomes that differ by a factor of ten or a hundred or more. As far as I know, there is nothing similar in the beta sciences. I predict that, as long as this situation continues to exist, politicians and the public will react by saying: "What are we supposed to do with these outcomes, for heaven's sake?". I will therefore try to provide a solution to this problem with the aid of the parable of the carpenter." (1996, published as Hueting (2001a))

Hueting recalls that Costanza was not amused. Likely, Costanza et al. were already starting with the *Nature* article while this parable was critical of their methods.

We may also observe that Costanza is a leading figure in the world of "ecological economics":

> "Daly says about Costanza: "He is extremely good at working and organizing. . . I continued to help out, but the entrepreneurship of the journal was really his". With Costanza, ecological economics got an entrepreneur who really knew how to manage in the highly competitive academic world." Røpke (2004:311)

Given this leading position it is especially unfortunate that Costanza saw no reason to reflect and publish on Hueting's results. Hueting's work actually invalidates Costanza's work on "valuing nature" yet it is quite ignored by him.

Currently, there is the initiative of the "Encyclopedia of Earth", see http://www.eoearth.org/:

> "(…) there are many resources for environmental content, but there is no central repository of authoritative information that meets the needs of diverse user communities. Our goal is to make the *Encyclopedia of Earth* the largest reliable information resource on the environment in history."

Dr. Costanza has been Topic Editor there for ecological economics, and a search on "Hueting", done on April 30 2008, provides only two citations, taking from the earlier book "An Introduction to Ecological Economics", edited by Costanza et al.. For the present author this is quite surprising, given the contribution of Hueting to our understanding of the economics of the environment.

Both the *Nature* article and this EoE cause one to raise one's eyebrows. At this moment in 2008 a conclusion is that Hueting has hardly had any impact in this field of "ecological economics", while, on the other hand, his concept of environmental function and design of environmental statistics are widely used in the United Nations SEEA – and in fact by Costanza et al. (1997).

It may also be noted that Hueting's position requires connections to the world of official national accounting and its economic theory. Alternative approaches, such as ISEW, Ecological Footprint, Genuine Progress Indicator, Genuine Savings and indeed the Costanza et al. (1997) figure arose from the world of the academia and are relatively easy to implement. Indeed, while eSNI has had only the slow development at one unique place, such other indicators are readily copied by various research groups all over the

world. The proliferation fills the scientific journals, rather detached from policy making, and the main effect seems that some research finding tickles a political body to generate more funds for more research. These alternative approaches, and the *Nature* article in particular, have drawn attention by researchers and the general public away from eSNI.

6.5 The Hueting Congress 1999

The 1999 Hueting Congress came about with subsidies from CBS Statistics Netherlands, various Ministries and Provinces, and the Committee of Recommendation was chaired by Dr. Jan Terlouw, former Minister of Economic Affairs. The occasion was held at the Royal Academy of Arts and Sciences in Amsterdam and the papers were edited by Ekko van Ierland, Jan van der Straaten and Herman Vollebergh (2001). The book constitutes an important document since it contains (1) a clear review of the theory by Hueting and Bart de Boer, (2) a calculation by Harmen Verbruggen et al. (3) opposing views, (4) rejoinders by Hueting that clarify the various misunderstandings. Hueting's rejoinders are especially enlightening.

To mention just one example, Pearce, Hamilton and Atkinson (2001) repeat the frequent criticism that Hueting replaces economics with politics. In their view Hueting requires the government to impose a level that defines sustainability and they rightly criticize this because of unreliability and political aspects. However, Hueting's rejoinder is that he does no such thing, and he in fact provides a great number of quotes from his publications in which indeed the opposite of that PHA claim is stated. His eSNI is conditional, "*if … then …*". The level and kind of use of nature that defines sustainability is established in the realm of the natural sciences, and economics only takes those as datum to calculate eSNI. This is just a calculation and not an actual imposition. The conditionality includes both the correctness of the sustainable levels of the environmental functions and the existence of preferences for sustainability. To the present author it is a mystery indeed why such intelligent economists fail to observe this difference between a conditional and an unconditional. Here, Pearce et al. mix "government" with "science".

The calculation of eSNI by Verbruggen et al. and the Hueting Congress provide an impetus for a World Bank seminar in 2001 where Minister Jan Pronk presents the first copy of the Congress book to WB President James Wolfensohn. Other seminars were held at the WSSD in the Johannesburg Earth Summit 2002 and at the OECD 2003. For Holland, the ESB dossier publications Van der Lecq (ed) (2001, 2005) must be mentioned.

7. The period up to 2008

7.1 Retirement

In 1994 Hueting turns 65 and retires from CBS Statistics Netherlands. The directorate allows him to keep his office and Hueting works almost as if still employed. This continues till the 1999 Hueting Congress. But shortly after that, in October 2000, the directorate decides that it is better to go separate ways. Hueting receives the special CBS medal and the directorate helps to install a PC with internet link at his home. "It felt like being fired," he confesses nevertheless.

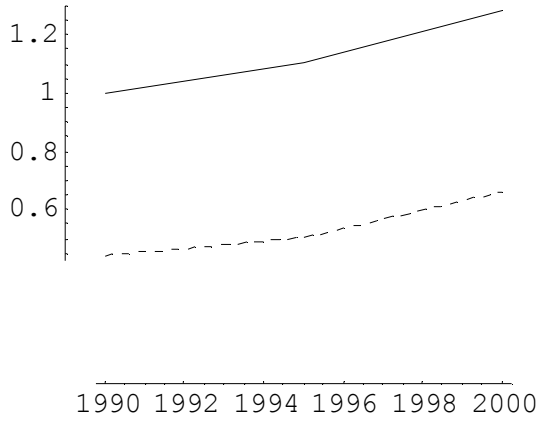
The directorate's decision also implied that Bart de Boer, Hueting's collaborator at CBS Statistics Netherlands, is reassigned to increasingly different activities. Eventually it is

decided by CBS that the research on eSNI is moved out of CBS, to become dependent upon external funds. This made De Boer decide to move to CE Delft to stay with the research and those funds. De Boer moves, but the (promised) external funds never materialized (see below).

7.2 Dutch eSNI trend 1990-2000

Hofkes, Gerlagh and Linderhof (2004) construct estimates for 1995 and 2000, and perform a decomposition analysis for the trend 1990-2000. Let us consider Net NI, constant trade shares, new equilibrium prices. [6] Over the period, Dutch NNI rose by 28% or 2.5% annually on average. eSNNI rose from 44% in 1990 to 52% in 2000, relative to NNI of each separate year, which can be seen as somewhat of a success. In constant values, eSNNI started at 44% and rose to 66% of 1990 NNI, thus grew 4% annually. Actually, the effort has not resulted in a reduction of the absolute gap. In 1990 the gap was 100% – 44% = 56% and in 2000 the gap was 100% – 66% + 28% = 62 %, and thus widened by 8% points, in terms of 1990 values. The results are depicted in **Figure 8**. It must be observed that these published values of eSNI have not drawn attention in Dutch Parliament or the media.

Figure 8: Dutch NNI (line) and eSNNI (dashed), 1990-2000, 1990 = 1



7.3 The Stern Review 2006

The Stern Review (2006), "The economics of climate change", is a momentous publication. It concentrates on global warming and also has a different methodology, so its results differ from the 50% found for eSNI:

> "(…) the Review estimates that if we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year,

[6] Addendum: The eSNNI indicator taken here is the proper eSNI. The other scenario's considered by Hofkes, Gerlagh and Linderhof (2004) are under their responsibility and are not supported by Hueting. Some authors criticize the concept of eSNI for the point that it would be ambiguous and depending upon assumptions. This is undoubtedly true to some extent, see the discussion elsewhere, but much "ambiguity" can also be avoided.

> now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more. In contrast, the costs of action – reducing greenhouse gas emissions to avoid the worst impacts of climate change – can be limited to around 1% of global GDP each year." (p xv)

The Review recognizes the issue of sustainability but chooses not to adopt it. Sustainability is defined and discussed on page 48 in the report. Importantly, it is accepted:

> "(…) it seems quite clear that, at the basic level, the global environment and ecological system, which provides us with life support functions such as stable and tolerable climatic conditions, cannot be substituted." (p 48)

However, in the next sentence, attention is limited to the greenhouse gases.

On p548, it is discussed that countries might take measures to become "more sustainable". However, sustainability is rather a dichotomous concept, i.e. a path is or isn't sustainable. The distance to sustainability can be reduced, but keep in mind that this may still be unsustainable.

The Review contains no reference to Hueting's work and this may contribute to its risky underestimate of the wider ecological challenge.

7.4 A missed chance for Germany and Eurostat

Hueting showed the present author an email by Walter Radermacher, the President of the German statistical office (Statistisches Bundesambt) and soon in 2008 the General Director of Eurostat:

> "Especially I do not think that target setting can in any way be done "objective" by the scientific community. On the contrary, in my opinion it is a core task to the societal and political discussion process." (Email by Radermacher to Hueting, 2007)

This repeats the misinterpretation that Pearce et al. (2001) have voiced as well, that Hueting's work would be politics or ethics instead of objective statistics, while the latter should be obvious from his work. Hueting observes that this email apparently was intended as a closing statement, an explanation of disinterest, and hence not an opening statement that started an enquiry. It is awkward to be sent a statement of disinterest that misrepresents your position.

7.5 A mysterious disappearance of a crucial subsidy

The calculations by Verbruggen et al. (2001) that were finished in 1999 were discussed in the appropriate commission in Dutch Parliament. In that discussion, Parliament passed a motion for continued research and Jan Pronk, Minister of the Environment 1998-2002, also speaking for the Minister of Economic Affairs, promised continued funding for model improvements and for eSNI estimates for other countries. However, this subsidy has not yet materialized as of 2008, causing six years of delay in research, including the impact that results would have had in those years. Hueting in April 2008:

> "In Autumn 2007, I attended the EU conference "Beyond GDP" in Brussels and encountered the official at the Ministery of the Environment who deals with eSNI. He said to me: "Well, Roefie, you can see that you missed the international connection." My reply was: "Only because the subsidy that has

been promised to Parliament for urgent improvements in the model and for calculations for more countries never has been paid out so that eSNI was killed four years ago." He replied: "No, not at all, that money had been included in the research fund for the Environmental Assessment Agency (MNP)." I replied: "But you advised negatively for the request for subsidy by SMOM for the eSNI." That request was by the CE project team for eSNI. The official: "In my judgement the MNP had already received money for that." I asked the management of the MNP whether their allocation had included this condition on eSNI. The answer was "No"."

This situation currently causes that two Ministers have not kept their promise to Parliament. This is only the latest event in a longer story that started around 2002 when that extended research on eSNI was discontinued.

8. Concluding remarks

The figure for national income (NI) is conditional on the assumption that market prices reflect the preferences, so that "more" means "better". During the last 40 years there is a theoretical crisis in economic theory because this assumption no longer holds since we know that preferences for sustainability cannot be expressed in the market when there are no adequate regulations in place. Governments all over the world have expressed an interest in sustainability. Mainstream economist then advise and support the growth of NI with the argument that this allows the finance of expenditures for the environment. In this way NI remains a target for economic policy. Pursuing this target however increases the destruction of the environment and the physical base for survival of large sections of mankind, and thus achieves exactly the opposite. The situation is like a patient who sickens from some medicine but the doctors upping the dose to cure this. What mainstream economists are not aware of is that NI has become entirely fictitious, and they neglect that there is a distinction between technological productivity growth using less resources and "productivity growth" that relies on continued destruction of the environment.

In these 40 years of research, Dr. Roefie Hueting has contributed not only to the development of environmental statistics and the related concepts now in use in the UN Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003, referred to as SEEA 2003, but he also provided a firm base in economic theory for dealing with the environment, by relating it to the notion of scarcity and linking up to the notions of Pigou, Robbins, and a string of economists working on social welfare and national accounting. Outstanding in this contribution is that he makes economists aware of the conditionality of NI while he also provides for the concept of eSNI conditional on the assumption of preferences for sustainability. Social welfare theory and national income and national accounting thus are shifted from a single tangent to the realm of decision making under risk.

It would be improper to reduce Hueting's research only to the topic of eSNI, the issue under consideration here. Nevertheless, on this topic Hueting encountered (i) support and encouragement, (ii) criticism with reasoned argumentation, (iii) a frequent criticism that science would be mixed with ethics and politics, which criticism changes the subject from science to politics, (iv) opposition and obstruction without argumentation or with mock arguments.

The first kind of response can impress us: the cum laude thesis, the support by Tinbergen, Pen and Hennipman, the support to a great extent by the directorate of CBS Statistics Netherlands, the interest and subsidies by Dutch Ministers and Parliament, and the international acclaim such as the UN Global 500 Award, the Hueting Congress, the seminars at international institutes such as the World Bank, OECD, WSSD, and the results already included in the UN SEEA.

We must observe, however, that by time of this writing eSNI has not been adopted by the community of researchers working on economic statistics and national accounts. The cause must lie with the other three responses.

With respect to the second kind of response this paper observed a surprising number of misunderstandings. Let us hope that these can be resolved in the near future. Note that such resolution mainly requires that economists study Hueting's existing work while it is less needed to do new research. The point made here namely is that this existing work is getting neglected. New research would rather be on new topics, given that the concept of eSNI has been accepted.

The third kind of response has played an important role. The argument that eSNI would be ethics or politics is unwarranted. Key researchers, both at CBS Statistics Netherlands and at institutes like EuroStat and the World Bank, apparently do not understand or accept the conditional assumption or "what if" approach to risk in national accounting. These scientists could have a scientific role just like Hueting has a scientific position but they hand the decision to calculate eSNI back to the political decision maker. Parliaments are advised to sooth these qualms by indeed taking the decision that eSNI is to be calculated and included in SNA alongside standard NI. Yet it must be emphasized at the same time that national statistical offices are scientifically free to decide themselves to calculate eSNI alongside NI. Even, there is the scientific obligation to explain what the current figure of NI stands for. The current reference to a "universal model" (see Bos (2007)) is quite inadequate, leaving us to wonder "a model of what?". It is not correct to present NI without adequate instruction what it means and while knowing that the user is likely to misinterprete it.

The fourth kind of response is important too since it means that there was not a level playing field. Over the course of many years, eSNI has frequently been rejected not for content but for petty causes. Key events were: (1) the six year delay in 1974-1980 in the English publication of "New Scarcity and Economic Growth", (2) the delay around 1996 by officials manipulating two Ministers and subsequently Parliament, that has also contributed to moving eSNI out of CBS Statistics Netherlands, (3) the disappearance in the community of "ecological economics", where Hueting's work is not mentioned or included, (4) the disappearance in 2002-2008 of research funds promised by two Ministers to Parliament. These observations are not pleasant but have to be made. This kind of response explains the slowness and friction.

This review has identified various steps of advance and adversity, some small some large. **Table 4** gives an overview of the larger events.

Table 4: Major steps of advance and adversity

Advance	*Adversity*
1974 Cum Laude thesis with Jan Pen	1974-1980 delay English publication
1965-1994 Support by Jan Tinbergen	1996 eSNI moved out of CBS
1994 UN Global 500 Award	No participation in the London Group
1999 Hueting Congress and book	1997 *Nature* article by Costanza et al.
Seminars at WB, OECD, WSSD	Non-reception in *Ecological Economics*
Calculation for 1990, 1995 and 2000	2002-2008 disappearance of research subsidy

It is debateable what a review like this can establish. However, it is worth a try. As said, the environmental challenge is wider than just climate change (or rather climate disaster), and both national income & production growth and their sustainable varieties provide important indicators or factors for economic welfare to guide us in the allocation of resources. **Table 4** paints the mixed picture of how the indicator for sustainable national income did not come into use yet. It is not always a matter of sound arguments. The events in the table mark the opportunities, both taken and missed, and it is important to see that key opportunities actually have been missed.

Jared Diamond (2005), in "Collapse: How Societies Choose to Fail or Succeed", contemplates world environmental sustainability, and considers how societies in the past have faced similar choices. One of his main suggestions is that the Dutch "polder model" might help the world to avoid a new collapse. Interestingly, the above has discussed events in Holland, and found that this "polder model" has only limited success in dealing with scientific information. A property of the "polder model" seems to be that it often comes into action only after some big disaster. Notably, Dutch climatologists Katsman et al. (2007) refer to the common estimate of a rise of the sea level by about 1 meter by 2100, and suggest "given the uncertainties" not to worry about rises above 1.5 meter. Yet, it are precisely those uncertainties, e.g. a surprise meltdown of Greenland, that turn the matter into decision making under risk and that would warrant precautionary measures. It is amazing that precisely Dutchmen are so mild to risks on the sea level. It is this blindness towards risk, and measures expressing that risk, that play such a key role in the issue of eSNI.

Colignatus (2008) extends on this discussion on environmental survival versus collapse by further clarifying the work done by Tinbergen & Hueting vis-à-vis Weitzman, Nordhaus and Stern.

In the flux of advance and adversity the latter force currently is stronger. In December 2009, Dr. Hueting hopes to turn 80. He is undoubtedly the only person alive with a thorough knowledge of the trident of welfare theory and national accounting and the environment. While he is with us, young researchers would benefit a lot from his experience. We can only hope that the leading economists of our days find time to reflect on the economic theory that he has been crafting so diligently.

The seminal contribution of Roefie Hueting to economic science: Theory and measurement of (environmentally) Sustainable National Income

"(...) my concern (... is ...) that the universally accepted compass of economic policy - changes in national income - is giving us the wrong signals about economic success." R. Hueting, 2000

Abstract

Roefie Hueting's work on (environmentally) Sustainable National Income appears to constitute a seminal contribution to economic science. Aspects are: (a) Definition. (b) Freedom. (c) Environmental functions. (d) Using a model in statistics. (e) Numerous details. (f) Blockages. (g) Foundation.

Introduction

Roefie Hueting has been writing on economics and the environment since about 1965. A reconsideration of his work leads to the conclusion is that it has a seminal quality and that Hueting may be counted as one of the major economists of our time - as worthy as each in Mark Blaug (1985)'s list. This paper gives an outline of Hueting's work, and intends to clarify why we are witnessing an important achievement.

Hueting's contributions concern the relationship of the indicators for National Income (NI) and (environmentally) Sustainable National Income (eSNI) - where it may be observed that it was Hueting who defined that latter concept. It is important to see that Hueting's work concerns economic statistics, both applied and with its theoretical foundations, so that there should be no confusion with economic policy making and future-oriented economic research. Hueting's objective is to provide adequate information to the users of statistical data. These data are generally used in a future-oriented setting but their value lies their statistical quality.

After Roefie Hueting's official retirement from Statistics Netherlands (CBS), a symposium was held in his honour in 1999, and the conference book appeared in 2001 under editorship of Ekko van Ierland, Jan van der Straaten and Herman Vollebergh. It is the study of this material, in particular, that caused me to write this paper. It is my impression that other readers will arrive at a similar conclusion.

It is useful to remember that Jan Tinbergen (Nobel Prize 1969) has always been a strong supporter of Roefie Hueting's work. He wrote a foreword to Hueting (1974), and he once even tried to organise a supportive committee for a prize of the United Nations. We should think about such things indeed when we see what Hueting has accomplished.

Setting

To understand Hueting's work, it is necessary to recall that national income accounting finds its *raison d' être* in social welfare theory. This has been developed in the period 1930-1950 by economists like Jan Tinbergen (NP 1969), Paul Samuelson (NP 1970), Simon Kuznets (NP 1971), John Hicks (NP 1972), James Meade (NP 1977) and Richard Stone (NP 1984). The basic issue is to compare two points in time and to determine whether welfare has increased or not. Since the Bergson-Samuelson social welfare function (SWF) is not observed, income - that follows from the tangent hyperplane - can be used as a proxy, and observed market prices can be used to deflate to real values. The basic statistical challenge thus is not income per se, but the development of welfare. Observed market prices were used because of the assumption of optimality - whence tangency.

Especially since we are living in democracies, it would seem to be a safe assumption that the current allocation indeed is the optimum decided upon by society. This classical approach to national income accounting however runs into problems when one can suspect that the resources are not used optimally and income is not tangent to the SWF - as would be the case for the environment since the 1950s.

The reaction of 'traditional statistics' to this challenge has been along the lines 'If people don't act up on their beliefs then we cannot measure it'. National Income is recorded at observed prices anyway, while separate indicators are provided on the state of the resources. Hueting's answer has been to hold on to the classical notion and to try to find the alternative tangent point. The difference in income then is a measure for the distance of the traditionally measured economy from the sustainable economy.

An analogy can help. Suppose that a medical doctor has been measuring the blood pressure of a client for some time and has been indicating that things have been OK. However, at some point he notes that the client should do more exercises. The client objects and says that the blood pressure still is OK, as it always was. The doctor then has to explain to the client that the proper concern always had been health in general and that actually more aspects are relevant than just blood pressure. There may have been changes to the arteries such that measured blood pressure no longer is adequate. To help the client to make the switch the doctor and the client henceforth can use both the blood pressure and the improved health indicator (that could for example be interpreted as the blood pressure corrected for the state of the arteries).

Indeed, modern economic agents and their parliaments and governments have appeared to be rather inconsistent in their opinions and actions on sustainability. They may state that sustainability could be a goal but they don't act in that manner. For example, a 1992 action programme of the European Union advocates "modification of key economic indicators, such as GDP, so as to reflect the value of natural and environmental resources in generating current and future incomes and to account for environmental losses and damage on the basis of assigned monetary values" (taken from Keuning (1992:9)). But the EU clearly is not adopting the required measures to achieve sustainability in reality,

hence market prices are off track and hence the traditional statistical methods are useless for measurement of an eSNI and for the correction which the EU asks. [7]

In this case the EU asked for an estimate, but as a good doctor, Hueting would measure the eSNI regardless whether the client asked for it or not. In a sense the doctor is forced to make expert judgement anyway since the client could not be fully informed or might be tempted to make biased estimates e.g. on the amount of exercise required. Hueting's approach clearly causes the question how a Statistical Office can be the judge of social preferences. If our complex social fabric does not generate the proper information, how could statisticians do so ? The answer that Hueting has provided is that statistics basically provides information based on assumptions *in all cases*. The traditional measurement of national income at observed market prices assumes optimality - because otherwise it is not sufficient to decompose between price and volume effects only. The classical measurement requires assumptions about what other conditions would constitute optimality. The statistician thus always provides conditional information, and should be clear about those conditions. Hueting also concludes that publishing the two measures simultaneously would be best from an informational point of view since this makes users more aware of the assumed conditions. This would indeed be the valid scientific approach.

National income accounting has appeared to be a sensitive political issue. The client has become preoccupied with the blood pressure count and seems to have forgotten why national income was being measured in the first place. This has seriously complicated Hueting's work but he maintained an admirable integrity. The situation also caused him to be more explicit about why the assumption about current optimality is untenable and why the alternative assumption of sustainability would be an acceptable statistical yardstick.

Specifically, Hueting developed the notion of 'blockages' to show how statistics can deal with the situation. The idea is that sustainability can be defined objectively and could be estimated (by the techniques that he developed). Implied in the concept of 'blockages' is that people would respect the standard of sustainability - even if they nowadays don't (are 'blocked'). The resulting yardstick thus does not impose preferences (a common misconception about Hueting's approach) but provides conditional information for the democratic process to be able to decide about actual adoption or not.

In policy making circles we can hear the argument that the benefits of calculating the eSNI would not outweigh the costs of the exercise. I have collected some data on the actual costs of statistical measurement for NI, the Environmental statistics, NAMEA and eSNI. These costs and the summary table are in the appendix. When we take the total costs of a national statistical bureau such as CBS Statistics Netherlands as the yardstick and consider the department-specific costs excluding overhead then the NI costs are 4.2% of its budget and the eSNI according to Hueting costs 0.25% - thus a quarter of 1%. For comparison, the Consumer Price Index (CPI) costs are 1.3% of the budget (excluding overhead). The reasons of these low estimates is that we are discussing high level statistical measures. These numbers do not contain all the surveys done and the low level

[7] This holds even when the EU would adopt the measures gradually and would gradually approach sustainability: on the path of convergence the traditional statistical methods would be improper. These methods are improper, since they don't use a model to correct market prices.

statistics - which are produced anyway because of other reasons. Environmental statistics for example are already produced for reasons of health and agricultural policy. What NI, NAMEA and eSNI do, is 'only' integrate the available data. A conclusion is that eSNI indeed is costly, since it does only tell us what we already know, which is that NI is wrong and that the environment is doing badly. But if we want to know by *how much* NI is wrong then the price is only marginal. In that respect this gives a situation where a small expenditure can cause lots of political upheaval, and perhaps this is a better way to understand the situation.

The above explains also how we could proceed to compare Hueting's eSNI with other indices developed by other economists. There are various such indices with the most prominent alternative being Herman Daly's "Index of Sustainable Economic Welfare" (ISEW). [8] Note that this current paper is not intended as a review of the literature on all indices and certainly I would like to avoid the possible misunderstanding that this paper makes a value judgement about these alternatives. The work by other economists on indices on sustainability is relevant and deserves attention. It is also difficult to make comparisons when work on such indices has been based partly on the work of Hueting himself. Thus, to be sure, this current paper only intends to explain the contribution of Hueting's work to economic science. However, the question about comparison arises naturally and an indication remains useful how such a comparison could proceed. Hueting's eSNI has been grounded from the start in the system of national accounts as the base for national decision making and he regards NI already as a contributing factor for a welfare index while other indices often call this system into question. Hueting tries to compare current NI with sustainability proper and he thus excludes the income distribution and an issue like 'work at home' which topics generally are in ISEWs. Hueting's eSNI thus shares some properties with the alternative measures, but none has all properties, while some add more, and overall there remains a distinct difference.

Hueting's contribution

Hueting's contribution consists at least of the following points.

(a) The development of the definition of 'sustainability' as a yardstick for economic performance and the development of the '(environmentally) Sustainable National Income' as the derived economic indicator.
Note: 'Sustainability' had been longer around as a word and vaguer concept. Hueting & Reijnders (1998) refer to J.S. Mill 1876 for notions of stationarity. Hueting's contribution however is the translation to modern economics.
Note: This thus distinguishes clearly the scientific definition from possible acceptance as a policy goal. While sustainability appears to be imprecise since it does not clearly specify which species are crucial or which might become extinct because of natural causes anyway, it appears that the imprecision is statistically manageable, and that the yardstick can be applied in practice.
Note: The eSNI for Holland has been estimated by Harmen Verbruggen e.a. (2001).

(b) The notion that it is freedom rather than income which is the relevant feature for sustainability. The freedom for future generations to use resources that are still available due to sustainable use by earlier generations.

[8] "Friends of the Earth" at http://www.foe.co.uk/ allows you to manipulate an ISEW for the UK.

Note: Amartya Sen (NP 1998, "Development as freedom" (1999)) has made the case for 'freedom' forcefully but the idea has been with Hueting all along - and Hueting has both stated its theory and employed it in a practical statistical analysis.

(c) The development of the concept of 'environmental functions' and the statistical measurement of these. At CBS Statistics Netherlands, Hueting has set a world standard of high quality statistics that uses the results of the natural sciences and biology and integrates those into an economic system.
Note: These environmental functions are related to Von Neumann technologies, where one resource can be relevant for different activities. The standard Von Neumann model is linear but with the natural sciences and biology there are all kinds of non-linearities.
Note: Hueting has been the founding Head of the Dept. for Environmental Statistics, at CBS Statistics Netherlands. He has been the guiding force in setting up their world famous environmental accounts, explicity calling in for the expertise of the natural sciences and biology. Also the innovation of the NAMEA - the National Accounting Matrix including Environmental Accounts as originated by Keuning (1992) which approach is very useful and fortunately also very influential in statistics - has only been possible because of the results created by Hueting and have been created under the supervision of both Keuning and Hueting. The NAMEA though cannot replace the need for an aggregate indicator based on welfare - see point (g) below. The eSNI calculated by Verbruggen op.cit. has been based on Hueting's work.

(d) The notion that statistics and statistical observation of the past can be extended by the use of applied general equilibrium models to 'backcast' the distance in the past of the actual path of the economy from some optimal path.
Note: This is a major advance compared to the common thought that statistics is observation without theory and models. In the common view observations can be used to develop and test theories, but no more, while now theories and models are shown to be relevant *in* observation as well. There are precursors to this idea, for example in Robert Fogel and Douglas North (NP 1993 "For having renewed research in economic history by applying economic theory and quantitative methods to explain economic and institutional change."). Hueting's advance is that he shows that this type of analysis is a natural part of the work that can be expected of a Statistical Office. Remarkably, Hueting still wishes to avoid a model as much as possible (see footnote 2) but accepts it when circumstances force him.
Note: With an appeal to the 'theorem' of Ronald Coase (NP 1991 "For his discovery and clarification of the significance of transaction costs and property rights for the traditional structure and functioning of the economy") one can argue that environmental costs are already included in actual observations and current national statistics. According to Coase's Theorem, property rights do not affect allocation but only the distribution of income. However, those 'implied environmental costs' are at current prices that do not reflect sustainable use. Thus a model is needed.

(e) Solving numerous details in actually implementing these issues. Valuation of non-market resources with reconstruction of 'demand and supply'. The difference between 'vertical supply' and vertical standards. Problems of asymmetric bookkeeping. That environmental use enters as a cost and not as an addition to

income so that the eSNI is lower than the NI. [9] Choice of the intertemporal welfare function - clarification that only the preferences of the current generation are relevant. Clarification on weak and strong sustainability. Identifying ecological risk factors, including the risks of assumptions on technology. Identification of the various points for sensitivity analysis.
Note: Hueting's treatment of technological growth shows how strikingly 'statistical' his approach is. When an eSNI is being estimated for one year in the past then his method accepts only the technology known in that year since no other techniques have been statistically observed for that year. (Non-renewable resources, such as oil, however are allowed a path for substitution otherwise they could not be used at all.) Hueting thus deviates from normal statistics in the use of a model and the issue of 'blockages', but remains a statistician in all respects. For other economists, whose frame of mind on policy making and technology is future-oriented, this is a crucial point to become aware of. To be more precise, Hueting is an economist who adapts economic theory to the new scarcities and then proceeds to develop the statistical theory and practical methods to measure social welfare and national income.
Note: Hueting's (1996) *Three Myths* paper is a nice example of the clarification involved.

(f) The development of the notion of 'blockages' in the economic process and national decision making.
Note: With reference to Coase's Theorem mentioned above, the blockages thus provide a case where that theorem fails to support a socially optimal situation.
Note: While a scientist easily runs the danger of stepping into the shoes of policy makers Hueting can be admired for never having done so. In some of his texts he enlivens the discussion by telling about his personal motivation for example to become an economist and to deal with the environment but he then clearly distinguishes this personal aside from the information generated for the decision maker. In fact, where other economists might be said to be rather lax with regards to the popular and political misconceptions about the NI indicator, Hueting sets a standard of scientific rigour for the quality of information.
Note: The co-ordination problem and the prisoners' dilemma are well-known in economics. James Buchanan (NP 1986 "For his development of the contractual and constitutional bases of the theory of economic and political decision making.") gives insights in the co-ordination problem, and John Harsanyi, John Nash and Reinhard Selten (NP 1994 "For their pioneering analysis of equilibria in the theory of non-cooperative games.") give insights in issues like the prisoners' dilemma. Hueting's contribution is to show that observation of such market failures can be a correct base for correcting statistical indicators.

(g) The development of the theory for the above and basing this theory on accepted notions of welfare analysis and the framework of national income accounting, and on Lord Robbins's definition of economics itself as the allocation of scarce means over competing ends.

---

[9] Keuning (1992:3) seems to contain this misunderstanding: "It can never entail that on balance something is substracted from NDP, as minimum enjoyment is zero." If environmental input first had a price zero and then becomes scarce with a price, then nominally the new input cost should be substracted from the earnings attributed to it - while the real consumption point, which is the relevant issue, would be lower.

Note: It is important that a new contribution to economics can be related to basic theory. Hueting's contributions do not diverge from the main stream but are directly in that main stream. This also makes for their powerful impact.
Note: As said, the notions for national income accounting have been developed by for example Jan Tinbergen (NP 1969) and John Hicks and Kenneth Arrow (NP 1972 "For their pioneering contributions to general economic equilibrium theory and welfare theory."). Important have also been Wassily Leontief (NP 1973 "For the development of the input-output method and for its application to important economic problems.") and Richard Stone (NP 1984 "For having made fundamental contributions to the development of systems of national accounts and hence greatly improved the basis for empirical economic analysis."). Hueting worked in this tradition and his contribution can be seen.
Note: Hueting's eSNI can be found by imposing sustainability conditions upon a model that contains only reaction functions and no social welfare function. These reaction functions however could be integrated, at least in theory, and then give a social welfare function anyway. Alternatively, one assumes a social welfare function and then derives the reaction functions. In both cases, the approximation of welfare by national income becomes superfluous since now the social welfare function has been given. Thus the use of a model undermines the original notion of economic statistics that mere income is used instead of the unobservable SWF. Nevertheless, there is much use in continued use of national income accounting.

Concluding remarks

Overlooking this list of achievements we become aware of the involvement of so many other people and institutions with Hueting's work. CBS Statistics Netherlands has provided a crucial institutional setting, the Dutch government provided additional research funds and also funded the symposium in honour of Hueting's work. Other researchers joined in at some moment like Jan Tinbergen or provided criticism like Steven Keuning op. cit. or Wilfred Beckerman and Herman Daly and others in the symposium book, which criticism allows us to better understand the issues. And many more. Yet during all this time, it was Hueting himself who created this list of achievements.

It is useful to remark that this does not mean that all problems have been solved. Much research needs to be done. For example, where the research on the eSNI according to Hueting has been done for one country only - Holland - the question now arises for other countries and the world as a whole. There is also the issue of the distribution of the resources of the globe to mankind as a whole, on which Hueting's SWF draws a blank. There also is the question under what conditions societies will be willing or able to actually switch to sustainability. [10] For example, as more resources will become subject to ownership title, the environment will be included more and more into the normal economy. This however does not mean that the normal NI indicator would eventually become sufficient. Ownership does not imply sustainable use. However, this means that statisticians face the enormous task of separating the two uses, while society itself has to

[10] Here is my own topic of interest, see Colignatus (2000a) on stagnation in national decision making, in particular with respect to unemployment. Colignatus (2000b) discusses the SWF regime switch.

find ways, if it opts for sustainability, to find mechanisms that make the sustainable use also the optimal choice at the individual level.

But, whatever this new research, it is striking that it will build on all this work. As once stated by Edward Leamer: "The success of an economist perhaps should be measured by the amount of employment he or she generates for other economists." In that respect, Roefie Hueting is likely to have a good score as well.

Note: I have submitted this text to Hueting and he has indicated that, apart from my hyperbole, it gives a fair representation of the content of his work. It is important to note this, since there have been many misunderstandings about what this content actually is. Economists often have not understood the ecological aspects, the ecologists often have not understood the economics, while it also happened that science has been mistaken for politics. In addition, I would like to remark that I have found it an honour and privilege to write this paper, and I would like to thank Hueting for his kind attention and patience.

Appendix: Cost of calculating eSNI

One frequently heard argument is that it would be too costly to calculate the eSNI, or that the benefit of calculating it does not outweigh those costs.

The costs are in Table 5. The Annual Report over 1999 by CBS - Statistics Netherlands gives total outlays of NLG 316 million, totalling the material costs and about 2300 FTE employees. We peg the exchange rate at the easy value of 1 $ = 2 NLG, and thus get a total cost of $70 thousand per FTE. The CBS Work Programme for 2001 provides detailed information per activity. I thank CBS for helping me retrieve all this information. I have averaged data where the Work Programme only gave Min and Max values. The eSNI project by H. Verbruggen c.s. was budgetted at NLG 0.5 million, though it may well be that the researchers also used their own research time. Though dr. Hueting is retired and thus does not 'cost' anything, we count him in at average cost.

Measuring eSNI costs about $ 390,000, or a quarter of 1% of total CBS outlays. To compare this with other statistics, CPI takes 1.3% and labour statistics take 3.3%.

The National Accounts Department requires 4.2%. This neglects all survey people and lower level statistical work, and just considers the work of integration - as we did for eSNI. A similar work of integration like NAMEA and SAM takes about 0.5% - twice of eSNI.

Given that the $ 390,000 tell us what we already know, i.e. that the NI is wrong and that the environmental situation is bad, the benefit/cost ratio indeed is low. But if you want to have an estimate of *how* wrong and *how* bad, the price does not seem to be so bad.

Table 5: Measurement cost of eSNI compared to the cost of NI, Environment and NAMEA

1999-2001	*FTE*	*$ million*	*% of CBS*
All Costs / FTE = $ 70,000	1	0.07	
CBS total	2300	158.00	100.00%
of which			
Labour statistics	76	5.19	3.28%
CPI	31	2.10	1.33%
National Accounts Dept.	96	6.56	4.15%
SAM, SESAME, NAMEA	12	0.82	0.52%
Environment	40	2.75	1.74%
of which eSNI at CBS	1	0.07	0.04%
PM. Idem (eSNI at CBS)	1	0.07	0.04%
PM. dr. R. Hueting	1	0.07	0.04%
eSNI project by Verbruggen	4	0.25	0.16%
eSNI total	6	0.39	0.25%

Sources: (1) CBS Annual Report 1999 and CBS Work Programme 2001, http://www.cbs.nl, (2) eSNI project, (3) 1 $ = 2 NLG

On the political economy of environmental survival versus collapse. Clarifying the work done by Tinbergen & Hueting vis-à-vis Weitzman, Nordhaus and Stern

Abstract

The Stern Review (2006) on the economics of climate change presented a cost estimate of perhaps even 20% of national income and subsequently was criticized by Weitzman and Nordhaus and others in a discussion that centered on the use of the calculus of variations and the choice of the proper rate of discount. The Tinbergen & Hueting (1991) approach deals with the wider environmental collapse, is not formulated in the form of the calculus of variations, and arrives at a sustainable level of national income of about 50% of national income. The Tinbergen & Hueting (TH) approach appears to be neglected by Weitzman, Nordhaus and Stern (WNS) but appears to be better grounded in economic theory, mathematically richer and empirically more relevant. This paper clarifies the misunderstandings and omissions in the work by WNS on environmental economics.

Introduction

Jan Tinbergen's 1929 Ph. D. thesis – his own copy apparently for sale for EUR 3300 at antiqbook – contains a decent amount of analysis in the calculus of variations, see Boumans (1992). This mathematical approach is also used by Martin Weitzman, William Nordhaus and Nicholas Stern (WNS) to discuss sustainable development and the economics of climate change.

Tinbergen (1903 – 1994) was also involved with the more practical problems of data gathering, national accounting, model formulation and number crunching. His attention in 1969 and 1990 was drawn to publications by Hueting, then head of the dept. of environmental statistics at CBS Statistics Netherlands, and this resulted in the Tinbergen & Hueting (1991) (TH) paper *GNP and Market Prices: Wrong Signals for Sustainable Economic Success that Mask Environmental Destruction*. Their approach appears to be very important, but it is not formulated in the language of the calculus of variations (though some parts are). Remarkably, Tinbergen (1985) does not refer to Hueting's work but the explanation must be that he takes this work so for granted that it does not occur to him that a reference might be useful. Tinbergen (1985:118) discusses

'counterproduction' (sometimes also called 'double counting' but nowadays called 'asymmetric entries' by Hueting). An example would be a catalyst for the exhausts from a car: the value added in its production should not be included in national income since it only restores the clean air that existed before.

Young econometricians currently trained in environmental economics tend to focus on the mathematically elegant approach of the calculus of variations while they have come to neglect the Tinbergen & Hueting approach, and, in path-dependency, they continue to neglect it. Even the Stern Review with its ethical approach to the calculus of variations neglects the TH approach on sustainable national income. Major critiques on the Stern Review were on the rate of discount and the ethics within the framework of the calculus of variations, but none of the widely cited economists referred to the TH approach, see Nordhaus (2007a) and Weitzman (2007ab) themselves but also e.g. Dasgupta (2007a) and Tol (2006), and also Quiggin (2006) on this discussion itself. If this neglect of the Tinbergen & Hueting approach continues, a major resource and strand of economic thought is left unused.

This present paper wishes to clarify the situation. The best approach is to take the angle from TH and comment on WNS. This ought to help readers of WNS – if not WNS themselves – to better understand the value of TH. This present paper can be seen as a companion to Colignatus (2009) that reviewed the earlier history of the TH approach. The TH figure for environmentally sustainable national income (eSNI) is about 50% of national income (NI), while the Stern Review arrives at costs of at most 20% of NI. This sizeable difference caused me to look deeper into the Stern Review and its critics.

Economists are a bit reluctant, as I myself, to think in terms of survival and collapse. Dupont (2008:47), writing in Volume 50 of *Survival*, a journal of the International Institute for Strategic Studies in London: "In the security domain, strategic doctrines and defence budgets are frequently justified on the basis of far less observable evidence than we have about the climate future which awaits us." He mentions various ecological risks in the same way as will be done below, clarifying that the terms of survival and collapse are proper, and that this indeed is the framework of discussion.

The G8 in Japan July 2008 stated that emissions of greenhouse gases (GHG) should be reduced by at least 50% in 2050, though not stating explicitly from what base year, although the Chair later said to intend 2008. In that respect, one of the major steps towards recognition seems to have been taken. However, taking only the index of GHG or even temperature seems insufficient to guide policy and it seems best to have an indicator for environmentally sustainable income (eSNI) alongside national income (NI). The following discussion thus is not only important for understanding the issue of survival versus collapse but also for the selection of the proper policy indicators.

The two approaches

The Weitzman, Nordhaus and Stern (WNS) discussion has an interesting structure. In particular: (1) Weitzman (1976) determines the stationary equivalent of future consumption, which can be interpreted as sustainable income for the market sector only. Then Nordhaus (1995), referring to Karl-Gustaf Löfgren 1992, extends the calculus with non-market resources. Shadow prices follow from a well-defined production function. (2) While Nordhaus and Weitzman see no cause for urgent action, the Stern Review (2006) advises to more active policies, emphasizing the risks of climate change, i.e. the catastrophies or events with low probability but high negative impact. The Stern Review

uses a low rate of discount for the actual calculations, and subsequently Nordhaus (2007a) and Weitzman (2007a) criticize that low rate. (3) Weitzman (2007ab) concludes that the 'traditional approach' in the calculus of variations – as used by the Stern Review but in fact also developed by Weitzman himself – neglects uncertainty and risk with respect to catastrophies. The certainty calculus in the Stern Review would not fit the texts on the risks. Weitzman then actually reformulates the calculus so that we now have a variant that can deal with some uncertainty. Then the road to more active policies is open again. It appears that the Stern Review uses a 'certainty equivalent' or an 'ethical reduced form' of a mathematically proper 'uncertainty calculus of variations'. Order and decency in economic advice are restored.

The mentioned mathematical structure makes philosophical sense. Ethics has everything to do with survival. Ethical issues relate to the functioning of the group with respect to survival of the group and the species. Survival not only relates to the everyday economic chores for food and shelter, where there is always the distinction between basic needs and luxuries, but survival comes clearly to the fore in all urgency under catastrophies such as fires, floods, bad harvests and so on. Where the Stern Review apparently lacked the mathematical sophistication that Weitzman so handsomely provided the Review still made sense where it formulated the issue with the tools at hand.

The TH approach formulates standards for non-renewable resources and eight environmental functions (space, water, soil, concentrations of nutrients, radiation, temperature, toxids, localities), and imposes those standards on the model.

> Therefore, the following procedure is proposed for correcting GNP for environmental losses (Hueting 1986, 1989). First define physical standards for environmental functions, based on their sustainable use. These standards replace the (unknown) demand curves. Then formulate measures to meet these standards. Finally, estimate the money involved in implementing the measures. The reduction of national income (Y) by the amounts found gives a first approximation of the activity level which, in line with the standards applied, is sustainable. Needless to say a correction for double counting, mentioned above, must also be made. If the sustainable level is Y', the difference between Y and Y' indicates, in money terms, how far society has drifted away from its desired goal of sustainable use of the environment.

Tinbergen & Hueting (1991)

Thus, in this piece of economic advice, on one hand there is the mathematically elegant approach of the calculus of variations and on the other hand there is the more practical and statistical approach. The two schools (with Tinbergen at bottom in both) have not yet come together, causing different policy advices, and this already lasts a number of years. Between Tinbergen & Hueting in 1991 and the Stern Review in 2006, both advising

strong action, there are already 15 years. In this day and age those 15 years mean a population growth of 1 billion people. Where Tinbergen & Hueting in 1991 were worried already by the past change of the world population from 4 to 5 billion, we now are in the worries about the current change from 6 to 7 billion. Quick effective action, e.g. possibly by turning development aid into family and pension planning policies, can mean a lot for environmental sustainability. This earlier window of opportunity has now been lost, perhaps because of mathematical formulation or perhaps because of political will. With the new sophistication by Weitzman we can observe that the mathematically elegant approach confirms the precautionary but perhaps less elegant approach by Tinbergen & Hueting. Hopefully, the two schools (with Tinbergen at bottom in both) can come together and there can arise some consensus in policy advice now, and a development of the particulars of that advice.

In fact, with the new Weitzman reformulation of the precautionary principle, the Tinbergen & Hueting approach stands rather vindicated and it would at least be curious why advice with a proven track record of wisdom is neglected, not looked into, not referred to and forgotten.

Interestingly, Tinbergen was a mentor for Tjalling Koopmans (1910 – 1985), see the obituary by Scarf (not dated), and Koopmans was a mentor for Weitzman, see Weitzman (2001) dedicating that paper to him, while also Nordhaus has been affiliated consistently with the Cowles Foundation. It may be hoped that the Tinbergen and Koopmans way of doing economics finds new inspiration for their younger generations. The current neglect of the TH analysis is not fitting to this figure in the history of economics.

A main point to observe is that the models in the calculus of variations considered by WNS are very stylized constructs that omit the prisoners' dilemma and negotiation costs of non-market resources. Precisely the latter are the very core of the environmental problem. The problem of co-ordination within a nation and between or across nations are the crucial issues here. On this count alone, economists would already focus on the TH approach. The following comments thus are rather on the fringe, caused by the particular properties of the WNS approach, but nevertheless still interesting and relevant for graduate students in the calculus of variations and for readers desiring to understand the political economy of environmental survival versus collapse.

Rightly scaring people

My own way of scaring people in Holland is, see Colignatus (2007) (in Dutch), by pointing to the fact, not the risk, that in a "business as usual" (BAU) scenario the Antarctica and Greenland ice will melt, causing severe flooding of Holland. [11] Raising dikes will be extremely costly, since sandy undergrounds require foundations, and more water filtering in from under the dikes anyway because of the increased pressure. The

[11] Addendum: In August 2008 I only mentioned the Greenland ice. A bit later, Katsman e.a. (2008) drew attention to the effect, surprising for an economist (and showing again that one cannot be careful enough), that the Greenland ice exerts a gravitational pull currently raising the sea level around Holland, so that its disappearance means a relative lowering. The overall effect is 25% of the eustatic rise. For Antartica the effect would be 110% though. So it is better to mention both Antarctica and Greenland. (And we cannot say "polar icecaps" since only land-based ice is relevant.)

drowning of Amsterdam need not happen this current century but in BAU it does at some time. Check:

> "Some temperature triggers, like 3 or 4º of warming, could be reached this century if warming occurs quite rapidly. (…) This would commit the world to increases in sea level of around 5 to 12-m over coming centuries to millennia (…)" Stern (2007)

Weitzman (2007a) is informative of the risk that it actually happens this very century:

> "Translated into the language of the simple model used here, such rare disasters are far out in the right tail of very high ΔT, which corresponds to being far out in the left tail of the consumption-growth random variable g. The probability distribution of long-run ΔT is disturbingly spread apart, largely because of structural-parameter uncertainty about the unknown "climate sensitivity" multiplier that amplifies GHG concentrations into ultimate steady-state greenhouse warming. The recently-released *Fourth Assessment Report of the IPCC* (2007) predicts for one hundred years from now a mean temperature change of further planetary warming (from averaging six "equally sound" marker scenarios) of $E[\Delta T] \approx 2.8°C$ with a thick-tailed upper-end standard deviation ≈1.6°C (Table SPM-3). This means the probability that $\Delta T > 4.5°C$ is approximately 15% and the probability of $\Delta T > 6°C$ is very roughly about 3%. IPCC does not extend its projections beyond 2105 on the basis that predictions into the 22nd century are too uncertain, but it seems unavoidable that the reduced-form probability of $\Delta T > 6°C$ increases substantially above 3% after the next century just from the enormous inertial lags for what by then will be in the climate-change pipeline. Societies and ecosystems whose average temperature has changed in the course of a century or so by $\Delta T > 6°C$ (for U.S. readers: $\Delta 6°C \approx \Delta 11°F$) are located in the *terra incognita* of what any honest economic modeler would have to admit is a planet Earth reconfigured as science fiction, since such high temperatures have not existed for some tens of millions of years." Weitzman (2007a)

When discussing other scare factors, Weitzman (2007a) reads like literature:

> "There is little doubt that the worst-case scenarios of global-warming catastrophes are genuinely frightening. The *Stern Review* goes over several of these highly-unlikely poorly-understood threshold-crossing disasters associated with abrupt large-scale irreversible changes in the climate system: sudden collapse of the Greenland and West Antarctica ice sheets, weakening or even reversal of thermohaline circulations that might radically affect such things as the Gulf Stream and European climate, runaway climate-sensitivity amplification of global warming due to positive-reinforcing multiplier feedbacks (including, but not limited to, loss of polar albedo, weakened carbon sinks, and rapid releases of methane from the thawing of arctic permafrost). More gradual but still very serious examples of uncertain climate-change effects are: sea-level dynamics, drowned coastlines of unknown magnitude, very different and possibly extreme weather patterns including droughts and floods, ecosystem destruction, mass species extinctions, big changes in worldwide precipitation patterns and distribution of fresh water, tropical-crop failures, large-scale migrations of human populations, humidity-nourished contagious diseases, and the list goes on and on." Weitzman (2007a)

Dasgupta (2007b) explains that economists – well, not TH, but their exception is not mentioned – have been deaf to arguments by ecologists:

> "Proposition 4 reveals the limitations of overly formal analyses of the economics of climate change. (We should add to that the economics of biodiversity loss.) I personally believe that Humanity should invest sufficiently so as to keep global mean temperature from rising beyond another 2-3 degrees Celsius, even though I realise that the expenditure that will be required to constrain carbon emissions will be a lot bigger than the mere 2% of the GDP of rich countries proposed by Stern (2006) if advancements in global sequestration technologies and technologies using alternative sources of energy are harder to realise than is currently hoped. But I am unable to justify that belief from any formal model. Ultimately, it is a "gut feeling" about the awful things that could occur if the global mean temperature were to rise another 5 degrees that should make us very scared.
>
> Climate change has been taken seriously by all economists who have studied the science since the late 1970s. Even the now-famous "hockey-stick", displayed by time series of carbon concentration in the atmosphere, appeared some time ago (Bolin, 1989: fig. 5). Moreover, the Second Assessment Report (1996) of the Intergovernmental Panel on Climate Change should have made us acknowledge climate change to be one of the most significant environmental issues facing Humanity. To be critical of the "economics of climate change" is not to understate the harm Humanity is inflicting on itself by degrading the natural environment - not only in regard to the stock of carbon in the atmosphere, but also in regard to so many other environmental matters besides. But the cause is not served by misplaced concreteness, especially not when parameter values are so chosen that they yield currently desired answers.
>
> For many years ecologists - more generally, environmental scientists - have asked economists to consider the "precautionary principle" seriously. We did not do so. I believe what they meant by the term was that we should not play down the possibility of environmental catastrophies - owing to climate change, species extinctions caused by habitat destruction, and so forth. The writings of Paul Ehrlich, James Hansen, John Holdren, Peter Raven, and E.O. Wilson have been critical here. What environmental scientists meant was that the uncertainties associated with the economic effects of environmental degradation are very great. But, as the uncertainties were meant to cover 200 years and more, no attempt was made to estimate those uncertainties. Our colleagues in the environmental sciences were correct not to have done so. Proposition 4 shows us the dangers of misplaced concreteness. (…)
>
> Economics helps us to realise what we are able to say about matters that will reveal themselves only in the distant future. Simultaneously, it helps us to realise the limits of what we are able to say. And that too is worth knowing, for limits on what we are able to say are not a reason for inaction. Climate change and biodiversity losses are two phenomena that are probably not amenable to formal, quantitative economic analysis. We economists should have not pressed for what I believe is misplaced concreteness. Certainly, we should not do so now." Dasgupta (2007b)

Note that Dasgupta's claim "Climate change and biodiversity losses are two phenomena that are probably not amenable to formal, quantitative economic analysis" is in conflict

with the Tinbergen & Hueting (1991) approach, recently updated by Hueting & De Boer (2001) and Hueting (2008). But Dasgupta does simply not refer to that line of research.

Where Dasgupta states "But the cause is not served by misplaced concreteness, especially not when parameter values are so chosen that they yield currently desired answers": there (a) the "desired answers" are derived from an analysis of risk, which is the actual economic analysis, both proper and sound, while the mathematical model is only a tool to enhance consistency, (b) he apparently does not see that the Stern Review choice of parameters reflects certainty equivalence, where, as said, a 'certainty calculus of variations' has to do the work of an (at that time not yet available) 'uncertainty calculus of variations', (c) the odium of "misplaced concreteness" falls on the critics of the Stern Review who do not see (a) and (b).

Possibly entertaining people

Following the 'stick and carrot' philosophy, and having mentioned the scare above, it seems proper to allow for some entertainment too. Weitzman's remark on 'science fiction' is tempting as well. In order to maintain the serious character of this paper, these more entertaining remarks are put in **Appendix A**.

Definitions of uncertainty and risk

Weitzman (2007a) explains his notions of uncertainty and risk: "The cost of low-g disasters from high-ΔT scenarios more properly constitutes uncertainty in the sense of Knight or Keynes than risk, because the scale and probability of these disasters are both unknown."

Earlier, Colignatus (1999, 2001) explained that this use of terms by Knight (or Keynes) is contrary to standard English:

> "The commonly adopted definitions of risk and uncertainty generate conceptual problems and inconsistencies, and they are a source of confusion in general. However, alternative and proper definitions are: (1) First there is the distinction between certainty and uncertainty. (2) Uncertainty forks into known (assumed) and unknown probabilities. (3) Unknown probabilities forks into known categories and unknown categories. (4) Known categories forks into 'including the uncertainties in the probabilities by explicitly assuming a uniform distribution' (Laplace) or neglect (or use other non-probabilistic techniques). Note that the term 'risk' has not been used in the 4 points above, so that an independent definition is possible. 'Risk' can be defined as the absolute value of probable loss, i.e. as (rho) $\rho = -E[X; X < 0]$. (…) The definitions provided here are directly in line with the Oxford English dictionary. It turns out that textbooks generally can keep their mathematics but will best rewrite their texts to these definitions. Not only the students and the general public will benefit from this sudden clarity, but eventually also statistics and economic theory themselves." Summary of Colignatus (1999, 2001)

We can be uncertain about parameter values, but that is not uncertainty *per se*. If the word "uncertain" causes conceptual difficulties here, say "unknown parameter values". But, of course, once this is understood we can say that parameter values are uncertain without getting confused on uncertainty *per se*.

A fat tail is not needed to get scared

Weitzman (2007a) elaborates that the uncertainty in the probabilities causes a reduced form with a fat tail, (exactly) like a normal distribution with unknown dispersion causes a Student-*t* distribution.

However, it is not true that a fat tail is required to get scared about catastrophes. It suffices to conclude that the probability is not zero, and then the extremity suffices for the impact. You may have to include above risk measure $\rho = -E[X; X < 0]$ as a separate entry in the utility function to become aware of this, though. This is precisely what Chapter 8, "Measuring Utility" by Colignatus (2001, 2007) does.

This discussion somewhat suffers from what Dasgupta rightly calls the fallacy of misplaced concreteness, though perhaps in a slightly different way. The point is that mostly everything is uncertain and that there may exist little certainty anyway. For example, I feel pretty certain that tomorrow the beach at Scheveningen will still be there, but, of course, neither I nor the beach may be there anymore. Where the Stern Review uses the 'certainty calculus of variations' it is mathematically proper to criticize it for not using the 'uncertainty' version, and it is mathematically impressive to create such a version, but it misrepresents the original idea that the whole exercise was intended to deal with the uncertainties of the future. It basically misunderstands that it is standard procedure in economics to use the 'certain' tools at hand, even while everyone knowns that subject matters in economics are generally uncertain (and especially the future).

Note that pure certainty is caught in the "Definition & Reality methodology", that uses definitions to say something about the uncertain future – see DRGTPE / Colignatus (2005). That piece of analysis is in fact presented as a somewhat new approach, given that normal analyses deal with uncertainties.

In the same vein it would be incorrect to criticize TH for not even using the calculus of variations or not inventing the right kind of calculus. It would be a valid mathematical observation but it would not be relevant for the economic analysis that is under concern. Instead of getting lost into this kind of critique, economists would do better in studying TH and improve on the economic analysis, using adequate mathematical and statistical techniques.

With respect to the Stern Review, one of the conclusions by Weitzman is:

> "However, in my opinion Stern deserves a measure of discredit for giving readers an authoritative-looking impression that seemingly-objective best-available-practice professional economic analysis robustly supports its conclusions, instead of more-openly disclosing the full extent to which the Review's radical policy recommendations depend upon controversial extreme assumptions and unconventional discount rates that most mainstream economists would consider much too low." Weitzman (2007a)

This is a valid mathematical criticism but not correct for a professor of economics. The economic analysis is primarily in the evaluation of the risks while the mathematical implementation is only a way to enhance consistency and clarity. Perhaps the hot potato is passed on to "most mainstream economists" who have not read TH and who have been neglecting the ecological warnings for years. But being in a majority only carries the weight of a majority and we should be more interested in some Elo-rating as in chess.

Somehow, the profession has not yet found a way to define a tournament but that in itself would be a strange kind of excuse in a discussion like this.

Facts, of the past and of reality

Above, I used the phrase "the fact, not the risk, that in a "business as usual" (BAU) scenario the Antarctica and Greenland ice will melt". Some readers may object to this use of language, since in their opinion facts occur only in the past, not in the uncertain future. Even a BAU scenario might contain an unforeseen discovery of cheap energy while a sustainable scenario might contain an unforeseen collapse.

Admittedly, I like to keep my use of language as strict as mathematics itself and thus the following comments can be clarifying. The phrase "the fact, not the risk, that in a "business as usual" (BAU) scenario the Antarctica and Greenland ice will melt" is an exact verbal translation of A = "Antarctica and Greenland ice will melt (to a significant amount)" and $\pi = P(A \mid \text{BAU}) = 1$, where the BAU scenario is defined as a certainty equivalent. The statement and context are rather not an issue of risk but rather an issue of conditionality.

The colloquial term "fact" tends to relate to the past but allows also for "reality" in which there is also a future. The dictionary by Hornby (1985) gives:

> "**1** [C] sth that has happened or been done (…) **2** [C] sth known to be true or accepted as true (…) **3** [U] reality; what is true; what exists (…)" Hornby (1985)

When the discussion context is the future, then people generally understand that the word "fact" is not used in the sense of referring to the past. It is reasonable to expect that people understand the word as an expression of truth and reality.

Let us consider a patient asking a medical doctor whether he will die. A generally acceptable answer is: "Eventually you will die for sure, but, *when*, my prognosis is (…)". It would be generally considered a bit of humour or sarcasm, depending upon the patient-doctor relationship, when the answer would be: "You will not die when they invent an immortality drug and you keep out of the way of fatal accidents."

Let A = "Antarctica and Greenland ice will melt (significantly)"
BAU = a "business as usual" scenario, defined as certainty equivalence
SUS = a "sustainability" scenario, defined as certainty equivalence
u = background risk from cases and probabilities not considered
other variables defined as in **Table 6**

Table 6. Clarification of certainty equivalence

Certainty equivalence, BAU and SUS	*Uncertainty,* BAU* and SUS*
$\pi = P(A \mid \text{BAU}) = 1$	$0 < \pi^* = P(A \mid \text{BAU}^*) < 1$
$\varsigma = P(A \mid \text{SUS}) = 0$	$0 < \varsigma^* = P(A \mid \text{SUS}^*) < 1$
$p = P(\text{BAU}) = p^*$ (alt. $p = p^* \pi^*$)	$p^* = P(\text{BAU}^*)$
$q = P(\text{SUS}) = q^*$ (alt. $q = q^* \varsigma^*$)	$q^* = P(\text{SUS}^*)$
$u = u^* + q^* \varsigma^* - p^*(1 - \pi^*)$ (alt. otherwise)	u^*
$P(A) = p\,\pi + q\,\varsigma + u = p + u$	$P(A) = p^* \pi^* + q^* \varsigma^* + u^*$

In terms of uncertainty, we would consider $p\ \pi$, which under certainty equivalence reduces to p. Some may hold that such certainty equivalence is not possible since the future is always uncertain. In the present state of environmental developments they are rather like a M.D. who seriously considers the chance of an immortality drug. In that case they presume a BAU* scenario as the true scenario with $\pi^* \neq 1$ and some p^*. However, we may define the BAU case with $p = p^*\ \pi^*$, and hence there actually is a certainty equivalence. It is clearer, though, to also include the SUS scenario and choose equal probabilities $p = p^*$ and $q = q^*$, which has been taken as the default case in the table. Note that there is a social welfare function (SWF) in each scenario so that the choice or the regime switch can be represented by a Meta-SWF(BAU, SUS), with the probabilities possibly seen as weights, see Colignatus (2000b).

Scenario analysis and cost-benefit analysis

In this respect, there also appears to exist a crucial issue when we consider scenario analysis and cost-benefit analysis. Note that with a Meta-SWF(BAU, SUS), as just mentioned, each path has its own utility function and parameters, and that the switch is an overall-preference. Colignatus (1992, 1995) used the notation SWF(x, I) where $I \in \{0, 1\}$ represents information or the regime. This approach helped me to understand the TH approach that I encountered only after 1992. When we observe the economy of a democratic nation, it is tempting, with Samuelson, to see the results as revealed preferences. For TH, these results may however also be revealed blockages. Prisoners' dilemma and negotiation costs may hinder the expression of the true preferences. In fact, there is uncertainty as to what the real preferences are. By consequence, it will not do to use a single utility function, to assume that the economy is in the Pangloss optimal state and then perform a cost-benefit analysis to another Pangloss optimal state – and this will not work since the original state is already optimal. Instead, we have to use different utility parameters for the different paths, allow each path to be optimal, and let the costs and benefits from switching be conditional, for example, if BAU is optimal with respect to SWF_{BAU} then it is suboptimal with respect to SWF_{SUS}, and if the latter would be the true SWF, then we can calculate the net advance from the costs and benefits of a switch from BAU to SUS. See Colignatus (2000b) for an example (included here as a chapter).

Note that the widely cited Bovenberg & De Mooij (1994) and the Ph.D. thesis by De Mooij (1999) on the 'double dividend' use only one SWF and thus are a bit less relevant for the proper policy question. Note too that when such analyses were to be performed with the calculus of variations, that there would also be another confusion to avoid, when translating the results to the real world (or a realistic model of the real world). The simplest models use uniform taxation so that the marginal rate is also the average rate. It would be standard economics, and fitting to the framework of optimization, to draw conclusions on the marginal tax rate. However, for reality, we should keep in mind that tax schemes have exemptions and are indexed on inflation or the level of subsistence. Therefor, the translation should not be to the statutory marginal tax rate but to the proper 'dynamic marginal tax rate', that actually would be closer to the average rate, see Colignatus (1992:272) or Colignatus (2005:140-145). [12]

[12] Addendum: See also Jaeger (2001, 2003) for a more traditional critique.

The Sterner & Persson approach

Sterner & Persson (2007) criticize the single sector (corn model) approach in the traditional form of the calculus of variations:

> "While we find no strong objections to the discounting assumptions adopted in the Stern Review, our main point is that the conclusions reached in the review can be justified on other grounds than by using a low discount rate. We argue that nonmarket damages from climate change are probably underestimated and that future scarcities that will be induced by the changing composition of the economy and climate change should lead to rising relative prices for certain goods and services, raising the estimated damage of climate change and counteracting the effect of discounting." From the Summary of Sterner & Persson (2007)

This argument thus has the same structure as the certainty equivalent to an uncertainty calculus of variations model. In this case the true model is disaggregated but it can be aggregated into an 'ethical reduced form'. Of necessity, these authors state: "If we were to have both low discount rates and changing relative prices, we would find even stronger support for firm and immediate abatement measures."

Of the various papers mentioned here, the Sterner & Persson paper comes closest to the TH approach and thus might be a bridge towards understanding.

A small note on calculating the damage

Weitzman (2007a) recalls the way how the damage due to climate change is calculated in this kind of study:

$$D(t) = Y^*(t) - Y(t) = f(\Delta T(t))\ Y^*(t)$$

"where t is time, D is the total damages of greenhouse warming, ΔT is atmospheric temperature relative to the base period, Y^* is potential GDP (or NDP, no distinction being made here) in the absence of any greenhouse warming, and Y is actual GDP with greenhouse warming." If I understand this correctly (but this may also be a formulation that is confusing to me) this approach assumes that there is some autonomous growth in Y^*, say $g = 2\%$, that is unaffected by environmental degradation. Thus:

$$D(t) = Y^*(0)\ (1 + g)^{\,t} - Y(t)$$

However, it is a bit strange to assume that 'no global warming' can come about without additional costs. Only when we are prepared to make costs then we may reduce global warming. Potential growth has to take place in an environment where growth becomes increasingly difficult due to environmental change. A Holland that builds dikes has less time to paint sunflowers.

Rather, one would prefer the Hueting & De Boer (2001:46) approach: "We work towards these goals by discussing a series of cases of increasing relevance to our problem: (1) preferences for environmental functions are unimportant because functions are abundant; (2) functions are scarce and preferences are such that the optimal path (computed by the model) approximates the actual path; (3) preferences for the environment are stronger than in the second case, but there are blockages preventing their full expression; (4) preferences are as strong as in the third case, but the blockages have been overcome; and

(5) the special form of the last case in which preferences for sustainability are general and dominant."

Apparently, $D(t) = Y^*(t) - Y(t)$ gives the difference between case 1 and 2, and can be denoted as $D_{1,2}(t) = Y_1(t) - Y_2(t)$. As said, this is only very hypothetical since path (1) is pure phantasy. Relevant are the costs of sustainability $D_{2,5}(t) = Y_2(t) - Y_5(t)$, where (5) creates the case that has temperature under some control.

Admittedly, there is a sense in which people regard 'the cost of temperature rise', as a conditional. Note that $Y(t) = Y(t \mid T(t))$. Then $D(t \mid s) = Y(t \mid T(s)) - Y(t) = f(T(t) \mid s)$, for e.g. $s = 0$ or $s = t - 1$ or $s =$ a value that gives sustainability. Thus when people see damages depend upon the temperature then this is rather a counterfactual than a potential. Controlled temperature might only be a potential if we were to invest in prevention, but it is not a given, something that can be seen as falling from the sky like manna. With $T(t) = T(t\text{-}1) + \Delta T(Y(t))$ we also note that production causes CO_2 exhausts and then a rise in temperature (likely with more lags), so that $Y(t \mid T(s))$ is not realistic for $s \neq t$.

It might be that the two approaches – either assuming some constant growth in "potential output" or the latter approach based upon the real production function – would be equivalent in practice with respect to the calculation of "costs". But the latter approach remains more tractable and true to fact.

Rate of discount

(a) Note that market rates of discount (observed rates of profit) do not substract for the non-market loss of environmental functions. For example, we would frequently like to see $r \approx g$, and the correction of g for environmental deterioration would similarly apply to r.

(b) In that sense, it may very well be that Nordhaus (2007a) who emphasizes the use of the market rate of discount too, has been less sensitive to Nordhaus (1995), who considers the non-market sector. See the next section.

(c) Addendum: Sumaila (2004) and Sumaila & Walters (2005, 2007) presented a discounting method that distinguishes the social intergenerational rate of discount (time preference) from the private intragenerational rate of discount (time preference). This definitely is an approach to consider.

(d) Addendum: Heijnen (2008) is clarifying notably on the zero rate of discount and non-renewable resources.

Nordhaus and sustainability

Professor Nordhaus has contributed importantly to environmental economics, with Nordhaus & Tobin (1971) *Is growth obsolete* and Nordhaus (1976) *Economic Growth and Climate: The Carbon Dioxide Problem* – with the apt statement "Unlike many of the wolf cries, this one, in my opinion, should be taken very seriously" – and with Nordhaus (1995) extending the calculus of variations with non-market resources, and subsequently the DICE model and geographical modeling.

There are three main points to observe.

(1) Nordhaus (1995) starts out with a promising paragraph:

> "With growing concern about our crowded globe and increasing awareness of global environmental problems, environmentalists and governments have launched a crusade for "sustainable economic development". This concept, popularized by the report of the Brundtland Commission (1987 / TC) and often adopted by critics of economic growth, was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The general notion here is that humanity is wasting its natural endowments – "natural capital" such as appropriated natural resources like energy resources, nonfuel minerals, and soils; appropriated renewable resources like forests and aquifers; and vital environmental resources like clean air and water, the stock of genetic material, and the present climate. The dangers range from mundane ones of trash to the more ominous ones of economic decline or even climatic apocalypse."

Subsequently, however, the paper (i) defines a mathematical notion of "sustainable income", (ii) fails to define and estimate environmental use, (iii) presents a notion of "knowledge" as a non-market resource relevant for "sustainability", (iv) measures this resource from total factor productivity (TFP) that still excludes the environment, and (v) then concludes "that consumption has historically been far below sustainable income". The reasoning is that future generations will have so much knowledge that translates in TFP that past generations have been a bit irrational in saving so much for descendants who will be rich anyway. This approach reminds of the 1928 lecture by John Maynard Keynes *Economic Possibilities for Our Grandchildren* (included in *Essays in Persuasion* – no reference needed). Nevertheless, it is a bit absurd to start out with the problem of environmental sustainability and the risk of apocalypse and see those disappear in the discussion and the conclusion.

In sum, the Nordhaus (1995) paper is enlightening for the concepts and mathematics involved but at the same time very confusing for the issue of environmental sustainability, i.e. what the Brundtland Commission (1987), Ahmad, El Serafy and Lutz (eds.) (1989), Hueting (1989a) and Tinbergen & Hueting (1991) are concerned about.

While many economists neglected the environment, Nordhaus stands out as one who took it serious, but his serious endeavour apparently obscures the fact that he did not take it serious *enough*. **Appendix B** clarifies this, starting with Nordhaus & Tobin (1971) and following the history of this line of research.

An important point in this appendix is: "According to Tinbergen & Hueting it is not a relevant discussion what to choose, either NI or eSNI, and economists should use both figures. The idea is to provide people with information about the state of the economy, and not to impose, as a caste of know-all economists, what kind of "income" people have to use."

(2) Nordhaus (1995) refers to Ahmad et al. (1989) – in retrospect a major publication on implementing sustainability in environmental accounting – and he refers specifically to the first 3 chapters but not specifically to Hueting (1989a), chapter 6 in that same volume. Economic science may have missed a crucial meeting of minds here. Nordhaus (1995), in other references, refers to again other authors on sustainability but neither to Hueting's other writings nor to TH. Also, there is no adequate channel from TH towards Nordhaus, as Hueting (2001b) clarifies that various of these authors have crucial misunderstandings about the TH approach.

(3) Nordhaus (2007b), *Key Potential Improvements in Statistics and Data for Policies Concerning Global Warming: The Role of Federal Statistical Agencies*, was prepared for the US National Research Council, Committee on National Statistics. It is relevant to note that Hueting developed Dutch environmental statistics and (in a personal communication to the present author) in the past has visited the US Bureau of Economic Analysis (BEA) and found little response to his suggestions.

Appendix C contains my own selection of Key points in Nordhaus's Key points. Here, it suffices to restate his summary recommendation:

> "(33) The summary recommendation here is that U.S. federal statistical agencies need to become even more active in the international statistical system if we are to improve international socioeconomic data for research in global warming. The quality of our models with a global public good like global warming is in a deep statistical sense a "weakest-link" technology. Obviously, the U.S. should not neglect its own data needs or improvements in its own system. However, in the global warming area, there would be a large payoff if the major federal statistical agencies could share their expertise to help countries with limited expertise and resources to improve methodologies and data systems." Nordhaus (2007b)

Apparently, Nordhaus considers Holland to have "limited expertise and resources" since the TH approach was not considered relevant to look into. It is also remarkable that the recommendation is formulated in 2007 while the issue is known since the 1970's. I don't intend to sound humourous or sarcastic, depending upon the author-reader relationship, but I don't think that it would be so advisable that the US comes to Holland to 'help out' with the Dutch environmental statistics – though it would really help out when some American students would be willing to listen and study.

Conclusion

This paper compared a Harvard – Yale approach with a The Hague – Voorburg approach. Jan Tinbergen was present at the roots of both approaches and would have wished integration.

The Stern Review (2006) scared the public and policy makers with costs of climate change that might even rise to 20% of national income. The Review also scared economists for its use of economic theory. Nordhaus (2007a), Weitzman (2007a), Dasgupta (2007a), Tol (2006) and others formulated strong critiques, see also Quiggin (2006) on this discussion and possibly Lomborg (2007) for a discussion for the larger public. These critics have a track record in economic publications on the environment and sustainability and it is striking that precisely these environmental economists have been so critical of the Stern Review.

As Aronson (1992) explains on the working of the human mind: if a smoker advises others not to smoke, then this has more convincing power than when a non-smoker does so. The assumption must be that having no vested interest increases impartiality. In the same way, environmental economists warning against the economics in the Stern Review will have more convincing power to the public and policy makers than those supporting it.

The Stern Review understated the environmental challenge by looking mainly at the issue of climate change and not the other issues that are caused by a world population

possibly rising towards two-digit numbers and often aspiring at material increase. And now the state of disinformation is increased and complicated by these strong critiques.

There is a subtle difference for environmental economists between a vested interest in environmental issues and a vested interest in a research tradition. When environmental economists warn against the economics in the Stern Review then their convincing power need not really be based upon the assumption that having no vested interest increases impartiality but might rather be based upon the confusion about the vested interest.

Clearly a researcher working in one tradition will have difficulty to switch, has a right to defend it and must be respected for doing so. The situation becomes more problematic when there is not shown awareness of alternative approaches. A time honoured element in the scientific method is the discussion of approaches by others.

The only way to clarify the situation is by considering the arguments. This paper has dutifully tried to do so. We have taken a position akin to Tinbergen & Hueting (1991), see also Colignatus (2009), have evaluated the various points and provided some criticisms to the Stern Review, some of its critics and some of the critics of the those, proceeding to the fourth level of critique. Then, while having kept an open and critical mind, we have returned to the original position: that Tinbergen & Hueting (1991) still provide the best approach, even though it is rather neglected in the economic literature.

A major point is that key authors in this debate mistook some techniques in econometrics for economics itself. This is a risk in economic research that Tinbergen has been warning about, see Jolink (2007), perhaps also out of personal experience. Historians may later judge that he helped to create a monster, namely a system of economic advice that puts higher value on technique than on content. Alternatively, they may find that such a system likely would have arisen anyway due to the Western cultural attitude to mathematical technique, but that Tinbergen managed to install some common sense – that is: if we follow his example.

Appendix A. Possibly entertaining people (continued)

Following the 'stick and carrot' philosophy, and having mentioned the scare above, it seems proper to allow for some entertainment too. Weitzman's remark on 'science fiction' is tempting as well. Let me admit that I write science fiction on occasion, see Acapulco Jones (2007), styled after Indiana Jones but with a better beach. Readers might also enjoy Terry Pratchett (2007) on the life of a Central Banker with a A.W. Phillips machine in the basement.

One point to observe is that, with Nordhaus partly in the right court, technology may hold wonderful surprises. On the other hand, the precautionary principle is that we cannot reasonably plan to have what we cannot reasonably expect to have yet. Past rates of growth are misleading since they are contaminated by wrong accounting for the environment.

But of course, our phantasy allows all kinds of escape routes.

An example is that our skin is modified to contain chlorophyll, cutting short the food chain. An example is a subsidy for small people, who indeed require less energy. Soon, the little green men are here.

Another idea is to consider the Mediterranean, concentrate sunlight by mirrors, catch and guide the humid air in pipes towards the Sahara and let water condensate there.

Colignatus (2006) is a bit more developed and contains two extravagant ideas, just in case that the world is not interested in the Dutch problem of saving Amsterdam. One idea is to use a gigantic geothermal machine, or a myriad of small ones, to create dikes from ice (also freezing the soft underground), and also take the CO_2 out of the air that other nations put there. That might really CO_2L IT. Another is to rearrange the Rhine river, that in the BAU scenario will cause a lot of inland problems too. Perhaps these approaches can be made feasible – I am not an engineer – and perhaps there is a Coase Theorem applicable here.

All these possibilities are as serious as the Weitzman (2007a) explorative remark: "Such emergency measures are likely to be so extreme as to be defensible only for an even-more-extreme environmental catastrophe in the making – perhaps they might include painting all human-made structures on the planet reflective white and creating a "Pinatubo effect" by seeding the upper atmosphere with metallic dust or aerosols. (footnote)". See Lomborg (2007) for similar suggestions.

Schuiling & Krijgsman (2006) are geophysical scientists who propose to grind olivine to sequester CO_2. This seems a more serious option than the statements above. Schuiling earlier suggested injecting underground limestone layers with acids to create gypsum, thereby raising the floor of Holland. The new label is "macro-engineering".

It stands to reason, though, that all such measures represent costs. These are expenditures required to restore what we had before environmental scarcity set in. When future newspapers report that Holland has an amazing "economic growth", due to the construction of dikes and similar projects, then this would derive from misguided national income accounting that masks that the Dutch are actually hurting a lot. In the work by TH we can find ways for proper national income accounting so that such costs do not contaminate our notion of "growth".

Appendix B. Nordhaus and sustainability (continued)

While many economists neglected the environment, Nordhaus stands out as one who took it serious, but his serious endeavour apparently obscures the fact that he did not take it serious *enough*. This appendix clarifies this, starting with Nordhaus & Tobin (1971) and following the history of this line of research. It will be useful to itemize the comments.

(1) On Nordhaus & Tobin (1971): (a) On catastrophes, they state:

> As for the danger of global ecological catastrophes, there is probably very little that economics alone can say. Maybe we are pouring pollutants into the atmosphere at such a rate that we will melt the polar icecaps and flood all the world's seaports. Unfortunately, there seems to be great uncertainty about the causes and the likelihood of such occurrences. These catastrophic global disturbances warrant a higher priority for research than the local disturbances to which so much attention has been given.

Clearly, ecologists in 1971 had different opinions. Thus, "economics alone" is not the proper reference.

(b) On the index of welfare: the inclusion of other items such as leisure is OK when the goal is to measure welfare from luxuries but the ecological discussion is about survival and no amount of leisure can substitute for a catastrophe.

(c) A more minor point, but still serious enough, is that Hueting (1974, 1980:183-184) criticizes the approach on urbanization.

(2) Nordhaus (1976) concludes to a "little change" scenario with a horizon of 20-40 years:

> In summary, an efficient program for meeting reasonable carbon dioxide standards appears feasible and, moreover, requires little change in the energy allocation for 20 to 40 years. Subject

But later the DICE model causes a similar conclusion – a drift of the horizon. This drift is perhaps due to the discounting, and perhaps this is like the temporal or dynamic inconsistency that may also affect the credibility of a Central Bank. Something to look into.

(3) Nordhaus (1995) gives a laudable extension of the calculus of variations referring also to apparently a similar paper by Karl-Gustaf Löfgren 1992. PM. As far as I have been able to see, Nordhaus (1994) contains a similar argument and was published outside of the Cowles Foundation; in contrast the Nordhaus (1995) paper apparently has remained a CF mimeo.

(4) The Nordhaus paper actually agrees with the Hueting approach, later adopted by Tinbergen & Hueting (1991), that both the standard measure for national income and the Weitzman (1976) sustainable national income for markets are inadequate when there are relevant non-market resources. Statistical offices around the world must be shocked to realize this. That is, they will know, conceptually, that such definitions exist, but to actually implement them, and to accept that a shortcut made in the 1930s is no longer sufficient for our times, is another story. Statistical offices that associate 'facts' with 'the past' and not with 'reality' that includes a future, have to face that paradigm switch.

(5) The various authors in Ahmad et al. (1989), and in particular Hueting (1989a) and Tinbergen & Hueting (1991), are concerned with environmental sustainability, while Nordhaus (1995) generalizes and in fact uses "knowledge" rather than "nature" as his prime example. This generalization is alright as a mathematical exercise but the economic problem was ecological survival and the required adaptation of economic accounting procedures to facilitate survival. Nordhaus's neglect of the basic problem causes all kinds of irrelevant criticisms. For example, he criticizes various authors for not including expected growth of knowledge in their notions of sustainable income. Yet knowledge is not the problem under discussion. In the literature at that time (e.g. Ahmad et al. (1989)), "sustainable income" meant "environmentally sustainable income". It is only because of this misunderstanding of the term "sustainability" that now the prefix "environmentally" has had to be added (turning SNI into eSNI).

(6) Nordhaus (1995) distinguishes different concepts of "income". Here he follows Hicks (1939) in *Value and Capital*. For unclear reasons Hicks's Definition 1 is labeled the

"Hicksian definition" (production for a limited period, maintaining capital, that however is defined on prospective returns) and Hicks's Definition 3 is labeled "Fisher's definition" (wealth based, condition on future income). Only the latter would be "sustainable income". This causes a curious criticism that authors who work on sustainable income and who say that they adopt Hicks's notion on income, would be inconsistent. Nordhaus also refers to the UN SNA that uses "Hicksian income" and that would become inconsistent if it would try to implement sustainability "in that manner". This is a very curious way of putting things. Rather, I find the TH position more tractable that the notion of "national income" (NI) is based upon Hicks's definition 1 and that the notion of "(environmentally) sustainable national income" (eSNI) differs from NI by corrections for environmental sustainability. Again, only the environment, for ecological survival, and not the luxuries. [13]

(7) In the TH work we also find that the definition of NI may well have been adequate at the time of Hicks, i.e. eSNI ≈ 100% NI, but that now eSNI ≈ 50% NI. According to Tinbergen & Hueting it is not a relevant discussion what to choose, either NI or eSNI, and economists should use both figures. The idea is to provide people with information about the state of the economy, and not to impose, as a caste of know-all economists, what kind of "income" people have to use.

(8) Note that Nordhaus (1995) confirms that when the economy becomes sustainable (in his formulas $A(t)$ constant), then NI = eSNI, which is also the TH position.

(9) TH basically calculate only one income value of a base year $Y(b)$, based upon a trajectory of $y(t \mid b)$, note the difference between Y and y, and they assume constant technology given that base year, and thus limited production growth. Their model thus is a specific application of the Nordhaus (1995) model (and not its solution). Conceivably, apart from this statistical approach, a planning agency might make projections of such $Y(t)$ with added expectations on technology. The relation between this $Y(t)$ and the various $y(t \mid b)$ is a bit complex, see Hueting & De Boer (2001).

(10) Nordhaus (1995) contains a very curious example of a "wayward spaceship" that contains a fixed amount of food without possibility of producing more. It does not help the discussion where he suggests that this might be the position argued by environmentalists.

(11) Nordhaus (1995) on risk: "A second point concerns the claim in some environmental writings that the capital-intact definition should apply specifically to "natural capital". (…) Natural capital has a claim to be maintained intact, they claim, because of risks, uncertainties, and irreversibilities in their use. These are more questions of religion than science. The fact that natural capital is misallocated means that we should use the appropriate shadow prices but surely does not imply that the appropriate policy is an absolute prohibition on declining natural stocks. Furthermore, risks, uncertainties, and irreversibilities are hardly unique to natural capital. (…) Natural capital has no natural monopoly on risk and irreversibility." This neglects that natural capital has a natural monopoly on survival, which is the relevant notion since we are discussing the ecological base of human existence. Thus: (a) "some writings" is

[13] For comparison, in the 2007-2008+ financial crisis, assets dropped 50% in value. This is registered as a loss in wealth and not a loss in income. There is scope for another concept of net income as merely the change in wealth, either positive or negative, but rather "income" captures the inflow like the flow of energy in a wire.

unspecified while TH give a well balanced exposition, (b) when the shadow price is infinite then prohibition ensues, (c) the risk that the Antarctica and Greenland ice melts is serious and for a long while irreversible, which is well-documented, (d) the fact that an investor can lose money is not relevant when we are discussing ecological survival. Clearly, Nordhaus (1995) did not fully understand the ecological challenge and it is striking that his references are not to ecologists directly but to economists who discuss the ecology – who need not understand the issue well either, see Hueting (2001b) who did take the ecological question seriously.

(12) The TH approach is to impose sustainability by standards / constraints and let the economy develop under those standards / constraints. TH subsequently discount with a zero rate to the base year. This is not quite the same as the problem of discounting in the calculus of variations. Nordhaus (1995) does not take account of this and as a result, we find various statements on discounting that are confusing with respect to the notion of sustainability according to the definition of Hueting as used by TH.

(13) Nordhaus (1995) states: "Third, sustainability is an insufficient criterion for judging the wisdom of a particular economic trajectory. (…) Hence there is no normative content in the designation of a path as "sustainable"." (a) This would be a welcome support for the TH approach, since that approach is frequently labeled as a political preference for sustainability, while TH hold that sustainability is an objective notion. (b) However, there is a subtle difference. In the TH approach, both NI and eSNI are conditional notions, based upon assumptions about the preferences of the economic agents. What the true preferences are is unknown and thus what the chosen path means is a bit unclear, except that NI is measured by the statistical office and eSNI is calculated as a model-based correction upon that (what best should be done by that statistical office too). When these figures become available as information to the economic agents, they might adjust their behaviour, with the subsequent year a new set of NI and eSNI. This is clearly a different kind of process than what Nordhaus has in mind, even though the statement still remains valid. (c) There is the notion of a Meta-SWF (social welfare function) that can bring about a regime switch, see Colignatus (2000b). (d) TH recognize that the Brundtland Report choice for sustainability would imply a preference. While they take sustainability as an objective notion and understand that people may have a preference for it, Nordhaus appears to deny the latter but the argument "there is no normative content in the designation of a path as "sustainable" has no bearing on a preference.

(14) Nordhaus (1995): "Fourth, some readers have complained that our treatment of natural capital is incomplete and inadequate. We have considered cases where natural capital is a perfect substitute for knowledge, which is clearly unlikely and may be grossly misleading. (…) In addition, we have omitted depletion of natural capital and corrections for externalities (…) We have done this because there are no reliable measures of depletion of natural capital (…) However, the results should not be interpreted as a Panglossian brief for profligacy or neglect. The estimates provided here may be off base if there are sudden or unpredictable declines in economic activity because of malfunctioning markets or unforeseen events. But the best remedy for avoiding disasters is good science not bad economics." This statement is a bit curious. (a) The Hueting, Bosch and De Boer (1992) publication at CBS Statistics Netherlands gave a decent methodology for the calculation of environmentally sustainable national income, which methodology might also be applied to the USA. Thus there was a measure. (b) Precisely because of the unpredictable events, economic science uses the precautionary principle. Thus, based upon this principle, one makes a best estimate, or provides various

scenarios, rather than fully neglecting the issue. Note that Nordhaus (1995) predates the Weitzman (2007a) analysis on uncertainty, but has the same "good science versus bad economics" attitude against the use of certainty equivalence. (c) This episode may be a case where lack or mismanagement of knowledge in 1995-2008 actually is a substitute for depletion of natural resources and environmental deterioration in 1995-X.

(15) In the conclusions section, Nordhaus (1995) provides support to TH that the UN SNA are defective with respect to "sustainable income". However, as said, his concept of "sustainable" contains a factor "knowlegde" based upon total factor productivity, that still neglects the environment. This is curious since the subject under discussion is environmental sustainability.

In sum, the Nordhaus (1995) paper is enlightening for the concepts and mathematics involved but at the same time very confusing for the issue of environmental sustainability, i.e. what the Brundtland Commission (1987), Ahmad et al. (1989), Hueting (1989a) and Tinbergen & Hueting (1991) are concerned about.

(16) For the apparent precursor Nordhaus (1994) we find an interesting conclusion:

> "The shame of the current generation in America is, contrary to much popular opinion, that it has probably overinvested in seductive areas like pollution control, farmland protection, and military R&D while underinvesting in dull areas like training, equipment, and applied research. This investment strategy is long in plants and mortars and short in plant and brainpower."

This conclusion is interesting in that some aspects convince by common sense (yes, better education) while other aspects are curious (worse pollution control ?). The article contains the same confusions as Nordhaus (1995) and the same lack of substantial research in the environment.

Appendix C. Nordhaus (2007b) on the role of federal statistical agencies

From the Nordhaus Key points (i) I wil select (1), (2), (8), … for the numbers that are relevant to the present discussion. Note by the way that most of this selection can already be found in the earlier writings of Tinbergen and Hueting.

(1) "The issues involved in understanding global warming and taking policies to slow its harmful impacts are the major environmental challenge of the modern era. These issues pose a unique mix of problems that arise from the fact that global warming is a global public good, is likely to be costly to slow or prevent, has daunting scientific and economic uncertainties, and casts a shadow over the globe for centuries to come. It is also likely to be a major public-policy challenge for the indefinite future, and therefore will require concerted efforts among natural and social scientists to understand its genesis, potential future paths, impacts, and potential strategies to slow or mitigate its impacts."

(2) "The challenge of coping with global warming is particularly difficult because it spans many disciplines and sectors of society and the natural world. Understanding the full ramifications involves areas of geosciences, ecology, economics, political science, domestic and international law. Each of these disciplines has a well-established group of researchers who are studying the implications and effects of global warming."

(8) “Second, understanding and modeling the “downstream” ecological, environmental, and economic effects of global warming are completely dependent on the results of the “upstream” geophysical sciences. In a sense, economists are sitting by the river retrieving the pearls or flotsam, as the case may be, of results from the upstream geoscientists and their modeling. If upstream modelers do not provide high-quality scenarios for abrupt climate change or sea-level rise or river runoff, then downstream economists and policy analysts cannot incorporate high-quality results into their models. In this respect, one respondent noted, “one of the greatest data/measurement needs for better economic analysis is for more refined (i.e. geographically specific) biophysical impact estimates from the natural sciences. For example, in the case of the United States, perhaps one of the greatest economic impacts of climate change will be in terms of snow pack and hence the flow of the Colorado River, on which much of western irrigated agriculture depends.” The economic analyses can get nowhere without reliable “upstream” geophysical analyses.”

(9) “(…) The IPCC working group charged with assessing the underlying science has, in the Working Group 1 report of the Fourth Assessment, apparently decided to avoid any probabilistic interpretations of emissions or climatic trajectories. As one researcher commented on this approach, without temperature ranges and associated probabilities, we “cannot do risk analysis of impacts, cannot show that there are near term risks, and cannot evaluate commitment to various levels of abrupt change.” Who knows what lurks in the tails of the distributions?”

(11) “Most of the researchers who responded to my inquiry about priorities for data mentioned prominently the abysmal state of our knowledge about the impacts of climate change. We can divide the terrain into market impacts and non-market impacts. In general, it is the non-market impacts that pose the major uncertainties. Within this category, we can subdivide those into managed and unmanaged systems. Human health and gardening are managed non-market activities, while ecological systems would be largely unmanaged. It seems likely that unmanaged systems are the major uncertainty. Researchers identify ecological “hot spots” as particularly vulnerable targets of climate change, particularly abrupt climate change. (footnote) Several respondents mentioned that we need, in one respondent’s words, “to accelerate our measurement of the use and impact of ecosystems and ecosystems services of value to people over the short and long term.”

(14) “Turning to the U.S. Federal statistical system, there is one glaring weakness – I would even say one catastrophic error of omission. This is the absence of an independent statistical agency that is dedicated to the design and collection of environmental and ecological data. Indeed, when I did a search of environmental statistics for the United States, I obtained an EPA web site that said, “The Environmental Quality Homepage is no longer available.” (…) It is hard to see how the U.S. can undertake serious research on environmental and ecological impacts without an independent statistical agency devoted to this task. The major recommendation in this area is that the Federal government move to develop an independent statistical agency that is devoted to design and collection of ecological and environmental data.”

(21) “(…) I strongly urge the Energy Information Agency to take stock of its mission in providing and supporting timely domestic and international data and long-term integrated energy and economic models relating to energy and emissions trends in global warming. The EIA could take a lead role in ensuring that energy and emissions data models used in global-warming studies are comprehensive and reliable.”

(22) “I mentioned above that the major gap in our understanding of the economics of global warming concerns impacts, particularly involving non-market sectors. A critical component is collecting better (or at least minimal) data on various non-market processes, particularly involving ecosystems and the environment. A second component is valuation. The third missing component is an organizing framework in which to place the quantities and values. This is the area of non-market accounts.”

(23) “There are several areas where a set of non-market accounts would be useful in developing impacts studies. One respondent noted that “the environmental accounting approach, and expanding that approach to non-market activities of the household, is a useful way to frame data.” Such activities as “outdoor activities, exposure, time spent in different activities – everything from caring for illness that may be environmentally related to time spent commuting – could help resolve why people make the choices they do, and how they would value having to change those choices.””

(27) “Issues of non-market and environmental accounting have occupied the Bureau of Economic Analysis (BEA) and CNStat for more than a decade. The BEA produced an early version of its environmental accounts in 1994. This report contained an early draft national balance sheet that contained estimates for non-produced assets. However, shortly after this, Congress issued a stop-work order. CNStat sponsored two reports that strongly endorsed non-market and environmental accounting, but BEA has undertaken only limited work in these areas.” [14]

(28) “The recommendation here is that the U.S. should move expeditiously to complete the work plan laid out by the BEA in 1994 and endorsed by two reports from the National Research Council on environmental and non-market accounting. To reiterate a recommendation from the NRC Report on this: “Extending the U.S. national income and product accounts to include assets and production activities associated with natural resources and the environment is an important goal. Environmental and natural-resource accounts would provide useful data on resource trends and help governments, businesses, and individuals better plan their economic activities and investments.””

(33) “The summary recommendation here is that U.S. federal statistical agencies need to become even more active in the international statistical system if we are to improve international socioeconomic data for research in global warming. The quality of our models with a global public good like global warming is in a deep statistical sense a “weakest-link” technology. Obviously, the U.S. should not neglect its own data needs or improvements in its own system. However, in the global warming area, there would be a large payoff if the major federal statistical agencies could share their expertise to help countries with limited expertise and resources to improve methodologies and data systems.”

[14] This compares with the earlier decades, see Bos (2003:25), quoted on page 32 above.

"Genuine Savings" at the World Bank

After the UNEP-WB project with the publication in 1989, to which Hueting (1989a) contributed, the World Bank chose for the "Genuine Savings" (GS) approach, as proposed by Giles Atkinson and David Pearce in 1993 and by Kirk Hamilton 1994, and jointly reviewed by Hamilton, Atkinson and Pearce (1997). Hamilton is the current World Bank Team Leader, Policy and Economics, Environment Department. It is encouraging to note that Lange (2003) in a World Bank publication considered the 1999 Hueting Congress book, Van Ierland et al. (2001).

Weak versus strong sustainability

There is the distinction between "weak sustainability" (WS), used in Genuine Savings, and and "strong sustainability" (SS), used in eSNI. Simon Dietz and Eric Neumayer (2004) explain the distinction (see also Neumayer (2003)):

> "The two are generally distinguished by the extent to which they assume natural and produced assets are substitutable. WS typically assumes infinite substitutability, while SS is based on the belief that natural capital is either entirely non-substitutable, or that a portion of it – the so-called critical natural capital – cannot be replicated by man-made capital." (…) "that despite various substantial problems, GS represents the best attempt at measuring (weak sustainability) WS so far and that it should become developed and improved over time."

They note:

> "Whether one believes in the policy-guiding value of GS depends at the outset on whether one subscribes to the WS paradigm. Admittedly, there have been moves towards dealing with the non-substitutability of natural capital within the GS framework. Atkinson et al. (…) propose that as the asset base of some natural resource is depleted up to its critical level, the shadow price of the asset should approach infinity. In practical terms, the magnitude of the term for natural capital depreciation becomes very large indeed. But there are, at present, limits to this approach. The loss of critical natural capital still needs to be measured through marginal WTP, and this is difficult enough for incremental as opposed to very large losses of welfare. In essence, we are not currently equipped to measure the welfare value of losses of critical natural capital. In that case, if one is concerned with SS, then GS results are largely uninteresting."

This mirrors the same finding by Hueting (1974) and forms the reason for his later development of eSNI. See also Hueting and Reijnders (2004).

The limited usefulness of WS also transpires here, Dietz and Neumayer (2004):

> "In any case, the fact that the World Bank's main estimates of GS are reversed for some countries when another, and not inferior, method for calculating natural

capital depreciation is used, sheds great doubt on the validity and reliability and, therefore, on the policy usefulness of the measure. For developed countries, GS produces the result that everywhere WS is attained. This may or may not be true. These countries are not especially resource-dependent, and do tend to invest significantly in capital formation. However, the inclusion of a more comprehensive range of environmental pollutants would undoubtedly drive GS downwards. The really interesting policy outcome that currently is difficult to ascertain with confidence is that some developed countries might be weakly unsustainable on the grounds of excess pollution."

The general conclusion is that weak sustainability is not relevant for proper sustainability.

Genuine Savings versus eSNI

Hamilton et al. (1997) and Hamilton (2002) do not refer to Hueting, presumably since they consider it obvious that their interpretation of "sustainability" is different. Thanks to the 1999 Hueting Congress we have the invited papers of Pearce, Hamilton and Atkinson (2001) and the Hueting (2001b) rejoinder. There are two key points, that hang together. The first is the emphasis of PHA on shadow prices rather than restrictions, the second is their idea that Hueting would want the government to impose such restrictions.

The use of shadow prices

Pearce et al. (2001:212) recall that Hueting considers shadow pricing "pointless" (in fact: impossible since the preferences cannot be determined) while their position is:

> "We take a different view in this study. We suggest that shadow pricing is essential for the concept of 'sustainable GNP' and that attempts to construct such a concept without shadow prices are arbitrary. (…) because of the difficulties of measuring sustainability targets and because, even where they can be defined, the marginal cost of achieving the last unit of sustainability is likely to be so large as to make the measure inachievable."

Pearce et al. want to use shadow prices but these would rise exponentially at critical levels. Pearce et al. (2001:217):

> "The point here is that setting sustainability as a goal is laudable, but its achievement could be extremely expensive, so much so that marginal benefits may be well below marginal costs as the target is approached."

Hueting rightly replies (2001b:368): "With opportunity costs we are not essentially concerned with money (…) but with a change in consumption pattern."

A restriction, like having a minimum age of 21 years for buying liquor, creates an impossibility, such that there need not exist a price to undo that impossibility. A 16-year old kid standing in front of the liquor shop might consider the shadow price of entering either infinite, when no bribe is feasible, or, when a bribe is feasible, either expensive or too high. From the standpoint of economic theory, it would seem that restrictions are more basic and it would not be correct to hold that everything would have a price. We cannot hold that there always is a price that can undo the impossible. For human imposed restrictions, the economic situation rather is an issue of enforcement, rather than that maintain that this can be undone with a bribe. It is unclear why PHA maintain that there "should" be a price, and it is unclear why Hueting's position would be unconvincing.

On the imposition of restrictions

PHA: "Roefie's view has been that governments represent a channel of 'revealed preference' so that the targets set by government act like shadow prices. But this presupposes a model of government rationality that is difficult to sustain. Indeed, it contains a contradiction." (p216). This however misinterpretes Hueting's approach. On p212 the authors write "by, in effect, assuming" but then on p216 they turn this into "set". In the rejoinder, Hueting (2001) rightly protests and emphasizes that it is "assuming". This is just the Hueting "*if … then …*" construction. It is non-plussing why these authors did or do not see the difference.

This misinterpretation occurred at various points in this review. Given the respect that we owe to professor Pearce I feel that some effort is required to understand his position. Professor Pearce sadly passed away in 2005. The obituaries rightly praise him. In one obituary, Turner (2005) recalls:

> "He did not believe in unfettered free markets and did see a positive role for government intervention. However, given his individualistic inclinations, he was deeply concerned by the threat posed by poorly motivated, unrepresentative and self serving government. Intervention in the economic and social life of people should ideally only be on the basis of some minimum norm 'mutual coercion, mutually agreed upon'. The cost penalty that is carried because of inefficient, ineffective, uncoordinated over regulation was unacceptable as far as Pearce was concerned, regardless of the well meaning motivation that lay behind the intervention."

The way that governments have treated eSNI may make one wary of governments indeed. Nevertheless, in Pearce's frame of mind there apparently is little difference between "assuming" and "setting". Either he did not fully understand the conditional aspect, or, in his eyes, by formulating a conditional "what if", Hueting would make the decision on what is sustainable *depend* upon some government whim. Pearce et al. (2001:223):

> "Precisely because we need checks and balances on what politicians decide it is important to keep economic valuation separate from the values implied by the political process. Otherwise there is a risk that whatever politicians decide is for the best is the best of all possible worlds, and that cannot be. Hence, for us, shadow pricing, inclusive of non-market valuation, is paramount."

But Hueting also wants that separation and expresses it clearly. It are scientists who decide what is sustainable or not. It is not logical for PHA to infer from a "what if" position to such political dependence.

There are two elements here. First there is the Hueting and Reijnders (1998) exposition that sustainability is an objective concept. In this case, statisticians working on national accounts do not have the liberty to second-guess ecologists but have to take the findings of other sciences as their data. (Of course never losing common sense.) Secondly, there is the political choice whether society would wish to attain such a target. Here, the scientist rightly points to the democratic process. Hueting then has the role of the scientist who provides "*if … then …*" information, *if* you want sustainability *then* this is where you are. This is indeed what one might expect from a national bureau of statistics, that anyhow already publishes an incomplete measure of national income.

Costs of calculation

What transpires from this kind of evaluation is that (i) one requires a sound method, (ii) one requires sufficient means to carry through that method. “Sufficient means” imply the resources of a national statistical bureau. Apparently, the GS approach breaks down on both. The World Bank considers the indicator for “Genuine Savings” experimental:

> “Frequently Asked Question: Do you have any data on wealth? Answer: Unfortunately we don't have a standard way of defining wealth. Wealth requires an evaluation of all productive assets, which accumulate (and depreciate) over years. This would also include measuring not just physical capital, but also human capital (education, experience, and perhaps social organization), and natural resources. This introduces additional complications of double counting (some financial assets represent ownership rights in physical assets) and offsetting liabilities (resulting from various complicated derivative-like instruments). On an experimental basis we have been publishing a measure of the additions and subtractions from total wealth. It appears in the WDI print edition as table 3.15, "Genuine Savings."” World Bank website FAQ sheet, May 1 2008”

Calculation of eSNI costs only 0.25% of the budget of CBS Statistics Netherlands for 2,500 people, while the Consumer Price Index costs 1.3% and the NI department itself 4.2%. Note that the 0.25% for eSNI is only possible because of the integration of work processes. The World Bank has 10,000 employees dispersed over more than 100 countries, has more jobs to do, but also relies on a “Development Network” next to a “Sustainable Development Network”.

Thus, while “Genuine Savings” are the World Bank indicator for sustainable development, it has experimental status and there are limited resources directed to it, not in line with would be required for an integration with the national accounts. All this leaving aside the question whether one would adopt the measure in the first place.

Conclusion

The WB might be advised to extend the funds for research on this topic and not to stick to only GS but also include eSNI.

Reaction to Bjørn Lomborg

(A) "The skeptical environmentalist", CUP 2001

Note: This was written on September 24 2001, before the UK Stern Review (2006), and has been polished up slightly. [15]

Introduction

I am not an environmental economist, only an economist who has some comments on the work of other economists who discuss environmental issues.

Also, my main advice is that democratic nations adopt a constitutional amendment for an Economic Supreme Court - see DRGTPE (Colignatus (2005)) or, if you are in a hurry, see the earlier working paper on the internet Colignatus (1996) (though DRGTPE improves on it). See also Colignatus (2009) for the 2007-2008+ crisis. Having an Economic Supreme Court makes that science gets a level playing field with political management – and note that economics is the science of management of the state. Having an Economic Supreme Court makes that we have a better decision making structure to settle complex issues.

For example, Bjørn Lomborg's book is thick, and the issues are very complex, and few people will have the time and resources, and the capacities, to tackle these issues. Those who could tackle the issues, might decline the challenge, since politicians would not need to listen, and all the work done could well be fruitless. Hence, we should work towards having an Economic Supreme Court, well embedded in a democratic structure, that could provide guidance in such complex issues.

Since we do not have an Economic Supreme Court now, I think that it is pretty useless that I spend much time on the issue. I would have the capacity to do so, see my cv, but who would listen to me ? The following hence is preliminary. But the following comments are crucial - so if you read this, please pay attention.

Lomborg's book indicates that coping with the environment would cost about 2% of national income for the next 100 years. I myself have presented an analysis that solves unemployment and the stagflation issue - see DRGTPE - and for the US that amounts to perhaps 4% of national income and for Europe that would be decidedly more. So I can only urge that people also look into this angle of the DRGTPE argument. However, Roefie Hueting argues that a proper approach for the environment might well cost 50% of national income. Lomborg's book does not refer to Hueting's analysis. Given the complexities, we all should hope for an Economic Supreme Court indeed.

The following discussion will look at the Hueting - Lomborg difference.

[15] Addendum: We now have also Rennie (2002) on Lomborg (2001).

Three angles

First note these three angles:

(1) The Club of Rome report 'Limits to growth' was published when I had just started university. The report caused concern, but later I learned that it overlooked price and income effects, so I became more of a fan of Julian Simon. Also, while I was concerned more about the issue of development and world poverty, it was also obvious that dictatorial regimes prevented development proper. [16] Hence, I concluded that mass unemployment and stagflation in the OECD countries were the most important economic issue - and this became my topic of study. [17] The argument namely is: If we solve unemployment, then the OECD does no longer need trade barriers to protect its own employment, and then 'trade not aid' has a better chance to be selected as the proper policy. Also, if we solve unemployment in a decent way, then the OECD model of democracy presents a more convincing model for developing countries. Hence, it was with joy and relief, when I finally could present, after years of study, an analysis on unemployment that solves it in a democratic manner (see DRGTPE). It is up to policy makers whether they adopt this policy, but at least the economic analysis clearly shows that it would be optimal if they did.

(2) In these last years I also got acquainted with the work of Roefie Hueting. He is not a pure environmental economist, since his focus on the interaction of economics and the environment is a bit special. He worked at CBS Statistics Netherlands and his topic is the statistical measurement of economic welfare. Given the importance of the environment, he neglects other aspects and concentrates on the environment. Taking the environmental data as given, he then considers the impact on national income accounting. Hueting basically provides a way to measure welfare if sustainability is the norm. In doing so, he is critical of the standard environmentalists who appear less versed in economics. But due to Hueting's work, I have grown more conscious of the environmental problem again: see my papers on his work.

(3) Interestingly, Lomborg now shows that many current environmental 'data' would be just as overly alarmist as the Club of Rome report was in the past. The 'data' that (likely also) Roefie Hueting's analysis relies on, might not be real data.

I find Lomborg's book lucid, illuminating, balanced, and very useful. It reads easy, has a clear reasoning, uses the relevant sources, and, indeed, exposes some rather shocking errors on the part of some participants in the debate on the environment. However, Lomborg apparently has not studied Hueting's analysis, and that makes the argument seriously unbalanced again.

Points in more detail

Combination of these three angles gives an interesting result.

(a) Both Hueting and Lomborg take the position of statistical scientists.

(b) Hueting is critical of the same environmentalists whom Lomborg criticises, so there is already the seed of agreement. However, Lomborg criticises the environmental data

[16] Addendum: Dutch readers may see Colignatus (1981).
[17] Addendum: The same reasoning is used by Moyo 's (2009).

and does not quite question the use of economics, while Hueting criticises the use of economics and does not quite question the environmental data.

(c) Though Lomborg e.g. on page 156 shows him aware of the issue of increasing scarcity and the rising prices of environmental functions, he at other points seems to make errors that Hueting has shown us to avoid. Lomborg relies heavily on the issues of economic growth and the measurement of welfare, which is precisely Hueting's topic. Lomborg writes: "(...) only when we are sufficiently rich can we afford the relative luxury of caring about the environment" (page 33) and "can we start to think about, worry about and deal with environmental problems" (page 327). Hueting however shows that national income commonly is meausured in a wrong manner. If we grow then it is precisely at the cost of the environment. Lomborg's graph on page 33 is improper. This is not only so, simply, since the 'high income' of the US depends upon pollution caused by imports from the poorer countries - as 'ecological footprints' could correct these. I have to be careful here, though, since the 'sustainability index' might do precisely that. More complex, however, is that Hueting shows that national income is the wrong index.

(d) Hueting's analysis remains valid whatever the environmental data. These data are taken as given, and the analysis can be performed whatever their value. For example, Julian Simon presented the argument of ever lower prices for raw materials, and Hueting's answer is that the environmental costs are not included in those prices. Lomborg may show that those costs would be much lower than commonly stated, but this does not invalidate the idea that those costs should be included. It would be a great advance in the statistical measurement of economic growth if this principle could be established.

(e) Hence, if statistician Lomborg adopts the analysis of statistician Hueting, and national income and economic growth get measured properly, then the next focus is on properly measuring the environment. Here Lomborg's critique on environmental statistics becomes relevant. But here the ecologists must react. Lomborg is rather convincing that a claim concerning 40,000 species is shockingly wrong - but it is not clear whether this claim was widespread or just from a few people. The true ecological worry may still be very relevant.

(f) Lomborg argues in the same way as I used to do: "(..) the major problems remain with hunger and poverty." (page 327) See here my analysis on unemployment, that shows that the main issues are social and psychological (DRGTPE). But, subsequently, due to Hueting's analysis, I have grown more conscious of the environment. Being rich also requires a certain use of natural resources, and this has an impact on the environment. Lomborg refers to the DICE / RICE models, but it is not clear whether this model is adequate. How does CO2 relate to temperature, and this again to the extinction of species? And again, national income should be properly measured in Hueting's fashion. I still discern a lot of uncertainty.

(g) Lomborg is optimistic about the possibilities of technology. Basically I am optimistic too, about the combinations of social and technical possibilities. But the issues of the future should not be confused with the issues of statistical measurement of the past. In the volume of Van Ierland (eds, to appear September 2001), Hueting replies to Wilfred Beckermann about such technological assumptions, and this applies here as well. For statistical measurement, we should rely on observations (known technology). And for forcasting technology we should do better than just punch in 2 percent productivity growth.

(h) Concerning the future, indeed, Lomborg has a decent discussion on the precautionary principle (page 349), but he does not really answer the key policy question since he does not use a model. He writes: "Of course, if large-scale ecological catastrophes were looming on the horizon we might be more inclined to afford the extra margin of safety just for the environment. But as is documented in this book, such a general conception is built on a myth." No, the book punches some major balloons, but it does not provide the econometric model required. Merely referring to DICE / RICE does not convince, see the argument above. Note that Lomborg himself (page 30) emphasises that we should use the best data and the best models - but apparently much work still has to be done.

(i) Lomborg has a discussion on discounting (page 314). Hueting emphasises that the rate of discount reflects a choice of preference. Zero interest is a preference for equality of generations, higher interest shows a preference for current generations. Hueting then adds: *But we don't know the preferences.* All kinds of mechanisms, like the prisoners' dilemma, prevent that true preferences are expressed in the economy. Thus, a statistician must provide all information, both the national income figure as currently measured, and the measure that includes the norm for sustainability. (Interestingly, Lomborg studied the prisoners' dilemma.)

(j) Lomborg uses the word 'risk' in a proper sense. However, he and other readers still could be interested in Colignatus (2001a) on the definition of risk. (In some respect, this is about how to aggregate risks.)

(k) If we combine the analysis on the environment and the one on poverty, then there is a really powerful statement - dealing with democracy and the structure of decision making.

Lomborg writes: "My point is simply to stress that in important fields of research it can also be difficult to present information which goes against institutional interest." (page 38). Of course, this should not happen in science. But apparently, it happened in the discussion on the environment - and it happened with my own analysis on unemployment.

Also, Lomborg writes: "In a surprisingly frank statement the UN states that "it is not the resources or the economic solutions that are lacking - it is the political momentum to tackle poverty head-on."" (page 66).

I noted that Lomborg also has an interest in voting theory himself, and I look forward to his reaction to my analysis here. The whole issue would also be relevant for Lomborg's colleagues at his political science department.

(l) On taxation, Lomborg discusses the 'double dividend' (page 308). He refers, among others, to an AER article by Bovenberg and De Mooij. However, this depends upon the treatment of taxes and for this there are alternative analyses. [18] Thus, also Lomborgs statements on the 'double dividend' are seriously flawed. [19]

[18] Addendum: See Colignatus (2005) on the dynamic marginal tax rate. Dutch readers can benefit from Colignatus & Hulst (2001:124).

[19] Addendum: See also Jaeger (2001, 2003) for a rejection of the analysis along lines of more traditional economics.

(B) “Cool it”, Knopf 2007

Lomborg (2007) reconsiders the case and deals with the Gore and Stern arguments.

(1) A major point now is that Lomborg no longer is an assistant professor in statistics but engages in policy advice on the future. The point is subtle. Consider two paths, business as usual BAU and sustainability SUS. Tinbergen & Hueting are concerned with calculating the eSNI at the base year using the information on SUS. Lomborg has a different position: (a) sometimes argueing that BAU is socially better than SUS, (b) sometimes questioning whether SUS is really sustainable and whether it should not be SUS*, (c) sometimes wondering whether we should rather target some BAU/SUS* path between BAU and SUS*. Thus, we find a quite different kind of discussion. Naturally, when true sustainability is SUS* rather than SUS, then also the eSNI will be affected. Thus there is a little overlap in these different realms of discussion. But the main focus of Lomborg now is “what are the costs and benefits of a choice ?” while Tinbergen & Hueting are focussed on “where are we ?”.

(2) A major type of argument by Lomborg is that BAU has advantages (e.g. less deaths from a warmer climate) that should also be included in the cost/benefit evaluation of SUS (thus more deaths than BAU due to maintaining the present colder climate). Here I would say: (a) Yes, all reasonable angles should be included. It would be very confusing when calculations would be biased, not only because of the bias but also because of the discussion about the bias. (b) It is necessary to accept that all scenario’s are man-made. Thus it will not do to take BAU as the status-quo scenario and to calculate SUS as the change that needs to show an improvement in welfare. The Tinbergen-Hueting point is that we do not know what is the true basic scenario. (c) Again, we first must have calculations on eSNI so that we have the proper information, before we can start proper discussions about what we would want to choose given that information. (d) It is important to see that the proper discussion is about risk and not about changes in social welfare that can be stated with certainty. Given what already has been calculated on eSNI and given what we know about the risks (i.e. that we don’t know enough) it is not unreasonable to be risk-averse and choose the conservative SUS path – and in the “where are we ?” discussion the option of sustainability thus should be put in that manner.

(3) Another major point is that Lomborg seems to have taken 2100 AD as a fixed target. But when writing in 2001 on 2100 then writing in 2007 would rather be on 2106, and so on. Tinbergen & Hueting anyway have a longer horizon. Admittedly, in the next 200 million years the continents are on the move and it may be doubted whether we can retain Amsterdam as it is. But if the sea level would rise by 50 meters in the next 300 years then it seems relatively myopic to stop thinking at 2100 AD. Archer (2009) “The long thaw” considers the next millenia but 300 years might do.

(4) Lomborg’s discussion of the reactions of his opponents (Schneider, Lynas, the IPCC, itself) and the dangers to the climate of discussion, is troubling. In that respect the “cool it” title is well-chosen. Lynas throwing of a cream pie in Lomborg’s face has hopefully been duly penalized. IPCC should control its language. Schneider’s recognition of the “unsolvable ethical dilemma” that a scientist also has a social responsibility is important. Scientists better always clarify what hat they are using when communicating to the general public. Lomborg’s suggestion for much more R&D can be supported and part will have to go to clean, effective and efficient communication.

Conclusions of this book

When completing this collection, the joint Dutch official scientific advisory agencies CBS Statistics Netherlands, CPB Central Planning Bureau, SCP Social Cultural Planning Bureau, PBL Netherlands Environmental Assessment Agency (formerly MNP) presented a "monitor for a sustainable Netherlands", CBS et al. (2009). Readers of *The Old Man and the SNI* will not be surprised to note that the Tinbergen & Hueting (1991) approach is not adopted. Notably:

(a) CBS et al. (2009) refer only to Hueting (1974) and asign the notion of eSNI to that publication. This is incorrect since the proper references are Hueting (1989a) and Hueting and De Boer (2001).

(b) CBS et al. (2009) take "sustainability" as a general concept also including social processes while the original problem was "(environmental) sustainability". [20]

(c) CBS et al. (2009) adopt various indicators and reject the idea of a single indicator but still maintain standard NI as a key indicator for "economic" evaluations. This is irrational.

It is laudable (a) that there is a wide scope for relevant topics, and (b) that the scientific advisory agencies co-operate. In the past there was some division e.g. between CBS on the past and CPB that took main responsibility for long term forecasts. Under request of the Cabinet there now is a joint endeavour. But is this really the result that an economic scientist can support ? The standard list of objectives of economic policy was: full employment, economic growth, price stability, external stability, fair equality of income and wealth. Later the environment was added, giving the notion of "sustainable economic growth". Obviously, it was never stated that other objectives were irrelevant or that only such aggregates sufficed. Nevertheless, CBS et al. (2009) is a radical step from accepted wisdom by eliminating inflation and external balance while distinguishing global warming and biodiversity as separate issues instead of combining them in environmental sustainability. My impression is that the Cabinet and its advisors would better rethink their approach.

This book hopefully has clarified the Tinbergen & Hueting (1991) approach and expressed support for it. The CBS et al. (2009) report by itself clarifies that there apparently still are huge misunderstandings amongst our colleagues and that those can only be resolved by a general study of the original writings by the original authors. This does not only hold for Holland but for the economic community at large.

[20] In Dutch, the title should rather read "Monitor Houdbaar Nederland 2009", with "houdbaarheid" different from "(milieu-) duurzaamheid".

Appendices

Abstract

Tinbergen & Hueting (1991) provide an approach to the economics of ecological survival that still is unsurpassed. Various "green GDPs" have been proposed such as ISEW, Ecological Footprint, Genuine Savings and Genuine Progress Indicator, and lately there is an increased interest in happiness as a re-interpretation of economic utility and social welfare. With respect to both ecological survival and requirements of economic theory these alternatives however fail. The Tinbergen & Hueting (1991) approach is (1) rooted in the fundamentals of economic analysis, (2) rooted in fundamentals of ecology, (3) applicable within the statistical framework of national accounting and henceforth fully practical, (4) demanding in economic and environmental expertise but concerning the resulting indicator of (environmentally) Sustainable National Income (eSNI) easy to understand by policy makers and the general public. Currently, statistical offices and economic advisory agencies over the world are implementing NAMEA systems for national accounting and derived indicators both for statistical observation and projections for the future. Policy discussions on ecological survival will be much served when researchers study in detail what these great economists have wrought. When an economist hasn't read Tinbergen & Hueting (1991) and Hueting and De Boer (2001) then an advice on economic growth and ecological survival is at risk to be misguided – as indeed is shown in the various cases.

Literature

EWP references are to the Economics Working Papers Archive at the Washington University at St. Louis: http://econwpa.wustl.edu. See also http://www.dataweb.nl/~cool.

Note: Colignatus is the name of Thomas Cool in science. Some archives may not recognize that name.

Many publications by Hueting can be found at http://www.sni-hueting.info

Ahmad, Y., S. El Serafy, E. Lutz (eds.) (1989), "Environmental Accounting for Sustainable Development", The World Bank, Washington, D.C.

Archer,, D. (2009), "The long thaw", Princeton

Aronson, E. (1992), "The social animal", Freeman

Blaug, M. (1985), "Great economists since Keynes", Harvester

Bos, F. (1995), "Economic theory and national accounting", CBS Statistics Netherlands NA-075

Bos, F. (2003), "The national accounts as a tool for analysis and policy; past, present and future", thesis University Twente, http://mpra.ub.uni-muenchen.de/1235/

Bos, F. (2007), "Use, misuse and proper use of national accounts statistics", National accounts occasional paper Nr. NA-096, CBS Statistics Netherlands Voorburg, http://mpra.ub.uni-muenchen.de/2576

Boumans, M.J. (1992), "A case of limited physics transfer. Jan Tinbergen's resources for re-shaping economics", Tinbergen Institute Research Series, 38

Bovenberg, L. & R.A. de Mooij (1994), "Environmental levies and distortionary taxation", American Economic Review, 94, 1085-89

Braat, L. and P. ten Brink (eds), (2008), "The Cost of Policy Inaction. The case of not meeting the 2010 biodiversity target", Alterra, Wageningen / Brussels, study for the European Commission, DG Environment, http://ec.europa.eu/environment/nature/biodiversity/economics/pdf/copi.zip

CBS Statistics Netherlands (1972d), "Waterverontreiniging met afbreekbaar organisch en eutrofiërend materiaal", CBS Statistics Netherlands, SDU The Hague ("Water pollution with decomposable and eutrofying materials").

CBS Statistics Netherlands, CPB Central Planning Bureau, SCP Social Cultural Planning Bureau, PBL Netherlands Environmental Assessment Agency (2009), "Monitor Duurzaam Nederland 2009", CBS Statistics Netherlands

Central Planning Bureau (CPB) (1972), "Economische gevolgen van de bestrijding van waterverontreiniging met afbreekbaar organisch materiaal", Monograph 16, The Hague ("Economic consequences of the abatement of water pollution with decomposable organic materials")

Central Planning Bureau (CPB) (1992), "Scanning the future", Sdu The Hague

Clark, A.E., P. Frijters and M. A. Shields (2008), "Relative Income, Happiness, and Utility: An Explanation for the Easterlin Paradox and Other Puzzles", Journal of Economic Literature, 46(1): 95–144

Colignatus (1981), "De NIEO is in ieder geval geen basisbehoeftenstrategie. Kritische kanttekeningen bij het Brandt-rapport", http://www.dataweb.nl/~cool/Thomas/Nederlands/Wetenschap/Artikelen/1981-07-20-NIEO-is-geen-BBS.pdf

Colignatus (1992), "Definition and Reality in the general theory of political economy; Some background papers 1989-1992", Magnana Mu Publishing and Research, Rotterdam

Colignatus, Th. (1995), “On the political economy of employment in the welfare state”, improved from the version included in Colignatus (1992), ewp-mac/9509001, with an again improved version in Colignatus (2005)
Colignatus, Th. (1996), “A constitutional amendment for an Economic Supreme Court”, http://www.dataweb.nl/~cool/Papers/Popular/Court.html
Colignatus, Th. (1999, 2001a), “Proper definitions for Risk and Uncertainty”, ewp-get/9902002, included in Colignatus (2005). See also http://www.dataweb.nl/~cool/Risk/index.html
Colignatus, Th. (2000a), “Definition and Reality in the General Theory of Political Economy”, Samuel van Houten Genootschap, ISBN 90-802263-2-7, http://www.dataweb.nl/~cool (see 2nd edition 2005)
Colignatus, Th. (2000b), “The choice on sustainability: information or the meta-SWF approach to a shift of preferences”, (with small corrections)”, Thomas Cool Consultancy & Econometrics, Report TC-2000-06-01/21, ewp-othr/0004004. Proper figures at http://www.dataweb.nl/~cool/Papers/Environment/Sustain.html
Colignatus, Th. (2000c), “The seminal contribution of Roefie Hueting to economic science: Theory and measurement of Sustainable National Income”, Thomas Cool Consultancy & Econometrics, Report TC-2000-11-01, November 29 2000
Colignatus, Th. (2001), “Roefie Hueting and Sustainable National Income”, translation of ESB, August 24, p652-653, available at www.sni-hueting.info
Colignatus, Th. (2001, 2007), “Voting Theory for Democracy”, (VTFD) Thomas Cool Consultancy & Econometrics (first edition 2001, second edition 2007)
Colignatus, Th. (2001a), “Proper definitions for Uncertainty and Risk”, http://www.dataweb.nl/~cool/Risk/index.html
Colignatus, Th. (2001b), “Roefie Hueting and Sustainable National Income”, is a translation from “Roefie Hueting en het DNI”, included in the series ‘Key Figures in Economics’, Economisch-Statistische Berichten 24-8-2001, p652-653, NEI, Rotterdam.
Colignatus, Th. (2005), “Definition and Reality in the General Theory of Political Economy”, 2nd edition, Dutch University Press
Colignatus, Th. (2006), “Two extravagant ideas on global warming and cooling Holland”, Samuel van Houten Genootschap, http://www.dataweb.nl/~cool/Papers/Environment/2006-12-14-GlobalWarming-CoolingHolland.pdf
Colignatus, Th. (2007), “Klimaatbeleid is een kwestie van beschaving”, Economisch Statistische Berichten, June 1, p317 (“Climate policy is a matter of civilization”)
Colignatus, Th. (2008), “On the political economy of environmental survival versus collapse. Clarifying the work done by Tinbergen & Hueting vis-à-vis Weitzman, Nordhaus and Stern”, Samuel van Houten Genootschap working paper, http://mpra.ub.uni-muenchen.de/10001
Colignatus, Th. (2008, 2009), “The Old Man and the SNI: A review of advance and adversity in Hueting’s research in economic growth and the new scarcity from the environment and sustainable national income (SNI)”, Samuel van Houten Genootschap, http://mpra.ub.uni-muenchen.de/12690
Colignatus, Th. (2009), “The current economic crisis: A solution that “lies buried and obscured in a mass of false theory"”, http://www.voxeu.org/index.php?q=node/3087
Colignatus, Th. and H. Hulst (2001), “De ontketende kiezer”, Rozenberg publishers
Cool, Th. (1999), “The Economics Pack, Applications for Mathematica”, Scheveningen, JEL-99-0820, ISBN 90-804774-1-9
Costanza, R. (2003), “The early history of ecological economics and the international society for ecological economics (ISEE)”, ISEE, Internet Encyclopaedia of Ecological Economics

Costanza, R., D. I. Stern, B. P. Fisher, L. He and C. Ma (2004), "Influential Publications in Ecological Economics: A Citation Analysis", Rensselaer Working Papers in Economics No 0408
Costanza, R., R. d'Arge, R. de Groot, S. Farber, Monica Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O"Neill, J. Paruelo, R.G. Raskin, P. Sutton and M. van den Belt (1997), "The value of the world's ecosystem services and natural capital", Nature 387, May 15, p253 – 260
Daly, H. (2001), "Roefie Hueting's perpendicular 'demand curve' and the issue of objective value", in Van Ierland et al. (2001) p137-150
Dasgupta, P. (2007a), "Commentary: The Stern Review's Economics of Climate Change", National Institute Economic Review, Vol 199, p 4–7
Dasgupta, P. (2007b), "Discounting Climate Change", Cambridge University mimeo
Diamond, J. (2005), "Collapse: How Societies Choose to Fail or Succeed", Viking.
Dietz, S., and E. Neumayer (2004), "Genuine Savings: A Critical Analysis of its Policy-Guiding Value", International Journal of Environment and Sustainable Development, Vol. 3, No. 3/4, p276-292
Dupont, A. (2008), "Climate catastrophe? The strategic implications of climate change, Survival Vol 50 no 3 p29-54
El Serafy, S. (1998), "Pricing the invaluable: the value of the world's ecosystem services and natural capital", Ecological Economics, vol. 25, issue 1, pages 25-27
Goodland, R. (2001), "An appreciation of Dr Roefie Hueting's ecological work", in Van Ierland et al. (2001) p315-332
Gore, A. and D. Guggenheim (2006), An inconvenient truth, Paramount
Haan, M. de, S.J. Keuning (1996), "Taking the environment into account: the NAMEA approach", Review of Income and Wealth 42 (2) , 131–148
Hamilton, K. (2002), "Accounting for Sustainability", the World Bank, http://info.worldbank.org/etools/docs/library/36500/AccountingForSustainbility.pdf
Hamilton, K., G. Atkinson and D. Pearce (1997), "Genuine Savings as an Indicator of Sustainability", http://www.uea.ac.uk/env/cserge/pub/wp/gec/gec_1997_03.htm
Hecht, J.E. (2007), "National Environmental Accounting: A Practical Introduction", International Review of Environmental and Resource Economics, 1: 03–66
Heijnen, P. (2008), "The Hartwick rule as a conservation law", http://ideas.repec.org/p/ams/ndfwpp/08-11.html
Hemingway, E. (2004), "The Old Man and the Sea", Arrow books
Hicks (1983), Collected essays on economic theory, volume III; Classics and moderns, Blackwell
Hicks, J. (1981), "Wealth and welfare" Collected essays on economic theory, volume I, Blackwell
Hicks, J.R. (1939), "Value and Capital", 2nd edition, Oxford: Clarendon Press
Hofkes, M. W., R. Gerlagh and V. Linderhof (2004), "Sustainable National Income: A Trend Analysis for the Netherlands for 1990-2000", Institute for Environmental Studies, Report R-04/02, June 28, Available at SSRN: http://ssrn.com/abstract=1009284
Hornby, A.S. (1985), "Oxford advanced learner's dictionary of current English", Oxford
Hueting, R. (1969), "Functions of Nature: Should Nature be Quantified?", London, World Wildlife Fund.
Hueting, R. (1974, 1980), "New Scarcity and Economic Growth: More Welfare Through Less Production?", Dutch edition: Agon Elsevier, Amsterdam; English edition: North-Holland Publishing Company, Amsterdam, New York, Oxford, 1980.
Hueting, R. (1981a), "Comments on the report "A Low Energy Strategy for the United Kingdom", compiled by G. Leach et al. for The International Institute for the Environment and Development (IIED)", Working Party on Integral Energy Scenarios, The Hague, 20 May.

Hueting, R. (1981b), De relatie tussen produktiegroei en energieverbruik, maakt groeifanatisme blind? ESB, nr. 3310, p. 609-611
Hueting, R. (1986b), "A Note on the Construction of an Environmental Indicator in Monetary Terms as a Supplement to National Income with the Aid of Basic Environmental Statistics", Report to Prof. Dr. E. Salim, Minister of Population and Environment, Indonesia. Jakarta, March.
Hueting, R. (1989a), "Correcting National Income for Environmental Losses: Towards a Practical Solution", in Y. Ahmad, S. El Serafy, E. Lutz (eds.) (1989)
Hueting, R. (1992), "The economic functions of the environment", in P. Ekins and M. Max-Neef (ed), "Real life economics", Routledge
Hueting, R. (1996), "Three persistent myths in the environment debate", Ecological Economics 18, p81-88. Reproduced in Van Ierland et al. (2001), p 78-89
Hueting, R. (2001a), "The Parable of the Carpenter", (with Bart de Boer), International Journal of Environment and Pollution, 15(1), pp. 42-50.
Hueting, R. (2001b), "Rejoinders to symposium authors: Ekins, Daly, Norgaard et al., Beckerman, El Serafy, Pearce et al., Faucheux and O"Connor, Verbruggen et al., Goodland and Mäler", in Van Ierland et al. (2001) pp 333-378
Hueting, R. (2003), "Ter overpeinzing op het wijde water. Voor Henk van Tuinen bij zijn afscheid van het CBS, van een vriend", ("To think about while sailing the seas. For Henk van Tuinen at his departure, from a friend") April, http://www.sni-hueting.info/NL/index.html
Hueting, R. (2006), "Het DNI & politieke belemmeringen", ("eSNI and political impediments") ((http://www.managementissues.com/duurzame_ontwikkeling/duurzame_ontwikkeling/het_dni_&_politieke_belemmeringen._20060605373.html
Hueting, R. (2008), "Why environmental sustainability can most probably not be attained with growing production", Conference on "Economic de-growth for ecological sustainability and social equity", Paris, 18-19 April
Hueting, R. and B. de Boer (2001), "Environmental valuation and sustainable national income according to Hueting", in Van Ierland et al. (2001) p17-77
Hueting, R. and L. Reijnders (1998), "Sustainability is an objective concept", Ecological Economics, 27(2), 139-47
Hueting, R. and L. Reijnders (2004), "Broad Sustainability contra Sustainability: The proper Construction of Sustainability Indicators", Ecological Economics 50, 249-260.
Hueting, R., c.s. (2000), "Prijs het milieu, niet het beleid", Economisch-Statistische Berichten 4244, February 25, p157-159 (Dutch)
Hueting, R., L. Reijnders, B. de Boer, J. Lambooy and H. Jansen (1998), "The Concept of Environmental Function and its Valuation, Ecological Economics 25(1): 31-35.
Hueting, R., P. Bosch and B. de Boer (1992), "Methodology for the Calculation of Sustainable National Income", Statistical Essays, M44, CBS Statistics Netherlands, SDU/Publishers, 's-Gravenhage 64 p. Also published as WWF International report, Gland, Switzerland, June 1992.
Ierland, E.C. van, J. van der Straaten and H.R.J. Vollebergh (eds) (2001), Economic growth and valuation of the environment, A debate, Edward Elgar, Cheltenham, UK – Northhampton, MA, USA
Jaeger, W. (2001), "Double dividend reconsidered", AERE Newsletter, November 2001, see http://arec.oregonstate.edu/jaeger/personal/researchpage.html
Jaeger, W. (2003), "Environmental taxation and the double dividend", in Online Encyclopedia of Ecological Economics (OEEE), see http://www.ecoeco.org/education_encyclopedia.php
Jolink, A. (2007), Weaving threads: Jan Tinbergen's statistical contribution to economic policy, Erasmus University Rotterdam, working paper mimeo

Jones, A. (2007), “Earth. Cuckoo in the phoenix nest”, Stichting Fantastische Vertellingen, http://www.lulu.com/content/1305054
Kapp, K.W. (1950), “The social costs of private enterprise”, Cambridge (Mass.)
Katsman, C. A., L. L. A. Vermeersen, W. Hazeleger, S. S. Drijfhout and G. J. van Oldenborgh (2008), “The Importance of Ocean Dynamics and Gravity Changes Induced by Ice Melt for Regional Scenarios of Sea Level Rise”, Geophysical Research Abstracts, Vol. 10, EGU2008-A-03655
Katsman, C.A., e.a. (2007), “Zee rijst, maar niet de pan uit”, NRC-Handelsblad 19 januari (“Sea rises, but not over the dikes”)
Keuning, S.J. (1992), “National accounts and the environment. The case for a system’s approach”, occasional paper NA-053, Statistics Netherlands (CBS)
Keuning, S.J. (1992), “National accounts and the environment: The case for a system’s approach”, CBS Statistics Netherlands, Occasional Paper Nr. NA-053
Keuning, S.J. (1995, 1996), “Accounting for economic development and social change”, IOS Press, Amsterdam
Keuning, S.J. (1996), “De fictie van een Groen Nationaal Inkomen”, S&D p479-483
Koopmans, T.C. (1947), “Measurement without Theory”, Review of Economic Statistics, vol XXIX, No 3, August, p161-172, see http://cepa.newschool.edu/het/profiles/koopmans.htm
Lange, G.−M. (2003), “Policy Application of Environmental Accounting”, The World Bank, Washington, D.C., Environmental Economics Series, Paper no 88
Lecq, S.G. van der (ed) (2001), “Dossier Vernieuwende statistieken”, ESB jaargang 86, no 4299 March 15
Lecq, S.G. van der (ed) (2005), “Dossier Ontkoppeling van milieu en economie”, ESB jaargang 90 no 4461 June 2
Lomborg, B. (2001), “The skeptical environmentalist”, Cambridge
Lomborg, B. (2007), “Cool it ! The skeptical environmentalist’s guide to global warming”, Knopf. Read in Dutch Translation, Het Spectrum 2007
Meadows, D.H. (1972), “The limits to growth”, New York
Mishan, E.J. (1967, 1993), “The Costs of Economic Growth”, Greenwood Press
MNP, Milieu- en natuur planbureau (2006), “Milieubalans 2006”, http://www.mnp.nl/bibliotheek/rapporten/500081001.pdf
Mooij, R.A. de (1999), Environmental taxation and the double dividend, Ph. D. Thesis Erasmus University Rotterdam
Moyo, D. (2009), “Dead aid”, Penguin
Neumayer, E. (2003), “Weak versus Strong Sustainability: Exploring the Limits of Two Opposing Paradigms”, 2nd revised edition, Edward Elgar
Neumayer, E. (2004), “Indicators of Sustainability”, in T. Tietenberg and H. Folmer (eds.): International Yearbook of Environmental and Resource Economics 2004/05, Cheltenham: Edward Elgar, p139-188
Noguchi, Asahi (1993), “General Equilibrium models”, in Varian (ed), “Economic and financial modeling with Mathematica”, Springer Telos 1993 pp 104-123
Nordhaus, W. D. (1976, 1977), “Economic Growth and Climate: The Carbon Dioxide Problem”, CFDP 435, CFP 443, American Economic Association (February 1977), 67(1): 341-346
Nordhaus, W. D. (1995), “How Should We Measure Sustainable Income?”, Cowles Foundation Discussion Paper CFDP 1101
Nordhaus, W. D. and J. Tobin (1971, 1973), “Is Growth Obsolete?”, Cowles Foundation Discussion Paper CFDP 319, CFP 398 with Comments and Reply. In Milton Moss, ed., “The Measurement of Economic and Social Performance”, Studies in Income and Wealth, Vol. 38, National Bureau of Economic Research, 1973, pp. 509-532, http://dido.econ.yale.edu/P/au/nordhaus.htm

Nordhaus, W.D. (1994), "Reflections on the Concept of Sustainable Economic Growth" CFP 951, in Luigi L. Pasinetti and Robert M. Solow (eds), Economic Growth and the Structure of Long-Term Development, St. Martin's Press
Nordhaus, W.D. (2007a) "The Stern Review on the Economics of Climate Change", JEL Vol 45 No 3 September, p686-702
Nordhaus, W.D. (2007b), "Key Potential Improvements in Statistics and Data for Policies Concerning Global Warming: The Role of Federal Statistical Agencies", Prepared for National Research Council (U.S.) Committee on National Statistics, May 10
Passenier, J. (1994), "Van planning naar scanning. Een halve eeuw Planbureau in Nederland", Wolters-Noordhoff
Pearce, D. (1998), "Auditing the Earth: The Value of the World's Ecosystem Services and Natural Capital," Environment, vol. 40, no. 2 (March)
Pearce, D., K. Hamilton and G. Atkinson (2001), "Valuing nature", in Van Ierland et al. (2001), p211-224
Pratchett, T. (2007), "Making money", Corgy
Quiggin, J. (2006), "Stern and the critics on discounting", University of Queensland, mimeo
Reich, U.-P. (1993), "The Dutch school of thought in national accounts", in De Vries e.a. (1993) p257-268
Rennie,, J. (2002), "Editorial: Misleading Math about the Earth", Scientific American, http://www.sciam.com/article.cfm?id=misleading-math-about-the
Robles, M. (1997), "Oplaaiende ruzies over Groen Nationaal Inkomen", Intermediair, 13 maart, 33e jaargang nummer 11, p55 and 57
Røpke, I. (2004), "The early history of modern ecological economics", Ecological Economics 50, p293– 314
Samuelson, P. (1950), "Evaluation of real national income", Oxford Economic Papers NS 2
Scarf, H.E. (not dated), "Tjalling Charles Koopmans. August 28, 1910 — February 26, 1985", http://www.nap.edu/html/biomems/tkoopmans.html
Schuiling R.D. and P. Krijgsman (2006), "Enhanced weathering: An effective and cheap tool to sequester CO2". Climatic Change 74, 349 - 354. See also the poster ftp://ftp.geog.uu.nl/pub/posters/2008/Let_the_earth_help_us_to_save_the_earth-Schuiling_June2008.pdf
Sen, A. (1999), "Development as freedom", Knopf, New York
Smith, R. (2006), "Development of the SEEA 2003 and its implementation", Ecological Economics, Volume 61, Issue 4, 15 March 2007, Pages 592-599
Stauvermann P.J. (2006), "Why and How Should We Account For the Environment?", Rensselaer Working Papers in Economics, http://econpapers.repec.org/paper/rpirpiwpe/0606.htm
Stern, N. (2006), "The economics of climate change: Stern Review on the Economics of Climate Change", Cambridge
Sterner, Th. and U.M. Persson (2007), "An Even Sterner Review. Introducing Relative Prices into the Discounting Debate", Discussion Paper RFF DP 07-37, July, Resources for the Future
Sumaila, U.R. (2004), "Intergenerational cost benefit analysis and marine ecosystem restoration", Fish and Fisheries 5 p329–343
Sumaila, U.R., C. Walters (2005), "Intergenerational discounting: a new intuitive approach", Ecological Economics 52 p135– 142
Sumaila, U.R., C. Walters (2007), "Making future generations count: Comment on "Remembering the future"", Ecological Economics 60, p487-488
The Economist (1998), "An Invaluable Environment", April 16
Tinbergen, J. (1985), "Production, income and welfare: The search for the optimal social order", Univ. of Nebraska Press, Lincoln & London, Wheatsheaf Books

Tinbergen, J. (1993), "Origin of national accounts and relation to economic theory", in De Vries e.a. (1993), p13-17
Tinbergen, J. and R. Hueting (1991), "GNP and Market Prices: Wrong Signals for Sustainable Economic Success that Mask Environmental Destruction", (with Jan Tinbergen). In (R. Goodland, H. Daly, S. El Serafy and B. von Droste zu Hulshoff (eds)), "Environmentally Sustainable Economic Development: Building on Brundtland", Ch 4: 51-57, United Nations Educational, Scientific and Cultural Organization, Paris, 1991. Also published in R. Goodland et al. (eds), "Population, Technology and Lifestyle: The Transition to Sustainability", Ch. 4: 52-62. Island Press, © The International Bank for Reconstruction and Development and UNESCO, Washington, D.C., 1992. Also published in R. Goodland et al. (eds), "Environmentally Sustainable Economic Development: Building on Brundtland", Environment Working Paper 46, The World Bank, Washington, D.C. See also www.sni-hueting.info
Tol, R.S.J. (2006), "The Stern Review of the economics of climate change: A comment", Hamburg, Vrije and Carnegie Mellon Universities, mimeo
Tuinen, H.K. van (1975), "Het begrip nationaal inkomen: corrigeren of niet?", ESB 5-3-1975 p221-224
Tuinen, H.K. van (1993), "Issues in Dutch national accounting 1970-1985", in De Vries e.a. (1993) p19-31
Tuinen, H.K. van (2008), "Innovative Statistics to Improve our Notion of Reality", paper for the OECD Global Project - Measuring the Progress of Societies, Conference, June 27-30 2007, Istanbul, Turkey, http://www.oecd.org/dataoecd/5/59/38780056.pdf
Turner, K. (2005), "The Blueprint Legacy – a review of Professor David Pearce's contribution to environmental economics and policy", CSERGE Working Paper PA 05-01, http://www.uea.ac.uk/env/cserge/pub/wp/pa/pa_2005_01.pdf
UN, EU, IMF and OECD (2003), "Handbook on Integrated Environmental and Economic Accounting (SEEA 2003)", Unstat, ST/ESA/STAT/SER.F/61 REV.1 (Final Draft)
Verbruggen, H. (ed) (2000), "Final report on calculations of a sustainable national income according to Hueting's methodology", Instituut voor Milieuvraagstukken, Vrije Universiteit Amsterdam, report O-00/10
Verbruggen, H., R. Gerlagh, M.W. Hofkes en R.B. Dellink (2001), "Duurzaam rekenen", ESB dossier "Vernieuwende statistieken", March 15
Verbruggen, H., R.B. Dellink, R. Gerlach, M.W. Hofkes and H.M.A. Jansen (2001), "Alternative calculations of a sustainable national income for the Netherlands according to Hueting", in Van Ierland (2001) p275-312
Vries, W.F.M. de, e.a. (eds) (1993), "The Value Added of National Accounting: Commemorating 50 years of national accounts in the Netherlands", CBS Statistics Netherlands
Weitzman, M.L. (1976), "On the Welfare Significance of National Product in a Dynamic Economy", Quarterly Journal of Economics, Vol 90 No 1, p156-62
Weitzman, M.L. (2001), "A Contribution to the Theory of Welfare Accounting", The Scandinavian Journal of Economics, Vol. 103, No. 1 (Mar., 2001), pp. 1-23
Weitzman, M.L. (2007a), "A Review of the Stern Review on the Economics of Climate Change", JEL Vol 45 No 3 September, p703-724
Weitzman, M.L. (2007b), "The Role of Uncertainty in the Economics of Catastrophic Climate Change", Discussion Paper, Department of Economics, Harvard University
World Bank (2000), "Beyond economic growth", Chapter IX. Growth of the Service Sector, http://www.worldbank.org/depweb/beyond/global/chapter9.html
World Commission on Environment and Development (WCED) (a.k.a. Brundtland Commission) (1987), "Our common future", Oxford University Press

Index

A

Ahmad, Y., 37, 78, 82, 85, 99, 102
Archer, D., 96, 99
Aronson, E., 79, 99
Arrow, K., 63, 101
Arrow's Theorem, 10
Atkinson, G., 49, 51, 88, 89, 101, 104

B

Baumol, W., 38
BEA, 29, 79, 87
Beckerman, W., 63, 102
Bergson, 11
Blaug, M., 57, 99
Boer, B. de, 3, 10, 21, 51, 72, 76, 83, 84, 97, 102
Boer, M. de, 39
Bos, F., 24, 29, 32, 55, 87, 99
Bosch, P., 84, 102
Boumans, M., 66, 99
Bovenberg, L., 75, 95, 99
Braat, L., 22, 99
Brink, P. ten, 22, 99
Brundtland Commission, 12, 37, 38, 78, 84, 85, 105
Buchanan, J., 62
Butter, F. den, 39

C

CBS Statistics Netherlands, 11, 21, 24, 25, 33, 36, 38, 39, 40, 41, 42, 44, 45, 46, 47, 48, 51, 55, 56, 57, 59, 61, 63, 64, 65, 66, 84, 91, 93, 97, 99, 102, 103, 105
CE, 52, 54
Central Bank, 40, 80, 82
Central Planning Bureau (CPB), 38, 39, 43, 45, 97, 99
Clark, A., 31, 99
Club of Rome, 93
Coase, R., 61, 62, 81
Colignatus, Th., 1, 2, 8, 9, 14, 20, 25, 30, 56, 63, 67, 69, 72, 73, 75, 80, 81, 84, 92, 93, 95, 99, 100
Congress, 51, 87
Constitution, 9, 62, 92, 100
Consumer Price Index, 59, 64, 65
Cool, Th., 2, 17, 99, 100, 103
Costanza, R., 48, 49, 50, 56, 100, 101

D

Daly, H., 37, 50, 60, 63, 101, 102, 105
Dasgupta, P., 67, 71, 72, 73, 79, 101
Dellink, R.B., 105
Diamond, J., 32, 56, 101
DICE, 77, 82, 94, 95
Dietz, S., 88, 101
Discounting, 76, 77, 82, 84, 95, 101, 104
DRGTPE, 9, 73, 92, 93, 94
Dupont, A., 67, 101

E

Ecological Footprint, 22, 27, 30, 32, 50
Economic Supreme Court, 9, 92, 100
Economist, The, 41, 47, 104
Edgeworth-Bowley, 17, 18
El Serafy, S., 37, 49, 78, 99, 101, 102, 105
Elo, 73
EPA, 86
EU, 24, 36, 53, 58, 59, 105
Europe, 24, 40, 41, 58, 70, 92, 99

F

Fisher. I., 83, 101
Fogel, R., 61
Freeman, R., 99
Frijters, P, 31
Frijters, P., 99

G

Genuine Progress Indicator, 22, 50
Genuine Savings, 22, 27, 50, 88, 89, 91, 101
Gerlagh, R., 52, 101, 105
Goodland, R., 21, 25, 37, 101, 102, 105
Gore, A., 8, 22, 101
Green, J., 37, 50
Groot, R..de, 101

H

Haan, M. de, 40, 101
Hamilton, K., 49, 51, 88, 89, 101, 104
Hansen, 71
Harsanyi, J., 62
Hartog, H. den, 39
Hecht, J.E., 40, 101
Heijnen, P., 77, 101
Hemingway, E., 21, 101
Hennipman, P., 55
Hicks, J.R., 7, 11, 13, 23, 29, 30, 44, 58, 63, 82, 83, 101
Hofkes, M., 52, 101, 105
Hornby, A.S., 74, 101
Hueting Congress, 9, 21, 24, 38, 47, 51, 55, 56, 88, 89
Hueting, R., 1, 3, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47, 48, 49, 50, 51, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 72, 76, 78, 79, 80, 82, 83, 84, 85, 88, 89, 90, 92, 93, 94, 95, 96, 97, 99, 100, 101, 102, 105
Hulst, H. en A. Hulst, 95, 100

I

Ierland, E. van, 25, 47, 51, 57, 88, 94, 101, 102, 104, 105
IMF, 36, 105
India, 24
Inflation, 75
Institutions, 29, 32, 33, 34, 39, 40, 43, 61, 63, 95
IPCC, 22, 70, 71, 86, 96
ISEW, 22, 27, 30, 32, 50, 60

J

Jaeger, W., 75, 95, 102
Jansen, H., 102, 105
Japan, 67
Jaszi, 29
Jolink, A., 80, 102
Jones, A., 80, 103

K

Kapp, K.W., 35, 103
Katsman, C., 56, 69, 103
Keller, W., 39
Keuning, S.J., 40, 41, 42, 44, 45, 46, 47, 58, 61, 62, 63, 101, 103
Keynes, J.M., 7, 72, 78, 99
Knight, F., 72
Koopmans, T.C., 32, 69, 103, 104
Krijgsman, P., 81, 104
Kruisinga, R., 35
Kuznets, S., 7, 11, 23, 29, 30, 44, 58

L

Lange, G.-M., 88, 103
Langman, H., 35
Leamer, E., 64
Lecq, S.G. van der, 51, 103
Leontief, W., 63
Lincoln, 104
Linderhof, V., 52, 101
Löfgrenm K.-G., 67, 82
Lomborg, B., 8, 79, 81, 92, 93, 94, 95, 96, 103
Lutz, E., 78, 99, 102
Lynas, M., 96

M

Majority, 47, 73
Mäler, K.-G., 102
Marginal rate, 75
Margolis, 29
Meade, J.E., 7, 11, 23, 44, 58
Meadows, D.H., 33, 103
Methodology, 13, 21, 24, 39, 49, 52, 73, 84, 105
Mill, J.S., 60
Mishan, E.J., 29, 35, 36, 103
MNP, Milieu- en natuurplanbureau, 42, 54, 97, 103
Monopoly, 39, 83
Mooij, R.A. de, 75, 95, 99, 103
Moyo, D., 93

N

NAMEA, 40, 41, 46, 47, 48, 59, 61, 64, 65, 101
Nash, J., 62
Neumayer, E., 88, 101, 103
Noguchi, A., 17, 103
Nordhaus, W.D., 9, 56, 66, 67, 69, 77, 78, 79, 80, 81, 82, 83, 84, 85, 100, 103, 104
North, D., 61
North, R., 61

O

Odum, E.P., 47
OECD, 24, 36, 37, 51, 55, 56, 93, 105
Okun, A., 29
Oomens, K., 34

P

Parliament, 39, 46, 52, 53, 54, 55
Passenier, J., 39, 104
PB voor de Leefomgeving (PBL), 97, 99
Pearce, D., 35, 49, 51, 53, 88, 89, 90, 101, 102, 104, 105
Pen, J., 11, 34, 55, 56
Persson, U.M., 76, 104
Petty, W., 38
Phillips, A.W., 80
Pigou, A.C., 28, 54
Pigou, C., 28, 54
Political Economy, 9, 21, 22, 24, 66, 69, 99, 100
Poverty, 93, 94, 95
Pratchett, T., 80, 104
President, 35, 51, 53
Preston, T., 35
Probability, 42, 67, 70, 72, 73
Productivity, 38, 54, 78, 85, 94
Pronk, J., 51, 53

Q

Quiggin, J., 67, 79, 104

R

Radermacher, W., 53
Random, 70
Reich, U.-P., 29, 104
Reijnders, L., 30, 37, 60, 88, 90, 102
Rennie, J., 92, 104
RICE, 94, 95
Risk, 21, 24, 26, 44, 45, 47, 54, 55, 56, 62, 68, 69, 70, 72, 73, 74, 78, 80, 83, 86, 90, 95
RIVM, 39
Robbins, L., 22, 28, 33, 54, 62
Robles, M., 42, 104
Røpke, I., 48, 50, 104

S

Salim, H.E. Emil, 38, 102
Samuelson, P., 11, 23, 44, 58, 75, 104
Scarf, H.E., 69, 104
Schneider, S., 96
Schuiling, R.D., 81, 104
SEEA, 36, 40, 47, 50, 54, 55, 104, 105
Selten, R., 62
Sen, A., 12, 61, 104
Shields, M., 31, 99
Sigmond, Th., 3
Smith, R., 40, 104
Social Cultural Planning Bureau (SCP), 97, 99
Solow, R., 104
Stagflation, 92, 93

Statistics, 11, 13, 28, 34, 37, 38, 40, 41, 44, 45, 47, 48, 50, 53, 54, 55, 57, 58, 59, 61, 62, 63, 64, 65, 66, 72, 79, 86, 90, 94, 99
Stauvermann, P.J., 41, 42, 104
Stern, N., 8, 9, 22, 52, 56, 66, 67, 68, 70, 71, 72, 73, 76, 79, 80, 92, 100, 101, 104, 105
Sterner, Th., 76, 104
Stone, R.A., 7, 11, 23, 29, 30, 44, 58, 63
Straaten, J. van, 51, 57, 102
Strong sustainability, 62, 88
Sumaila, U.R., 77, 104
SWF, Social Welfare Function, 14, 16, 17, 19, 20, 28, 30, 31, 44, 58, 63, 75

T

Technology, 16, 28, 45, 62, 79, 80, 83, 87, 94
Terlouw, J., 51
TFP, 78
Tinbergen, J., 1, 7, 8, 9, 10, 11, 13, 22, 23, 24, 27, 30, 33, 35, 38, 39, 40, 44, 48, 55, 56, 58, 63, 66, 67, 68, 69, 72, 78, 79, 80, 82, 83, 85, 96, 99, 100, 102, 104, 105
Tobin, J., 77, 78, 81, 103
Tol, R.S.J., 67, 79, 105
Tuinen, H.K. van, 21, 36, 42, 44, 45, 46, 47, 102, 105
Turner, K., 35, 90, 105

U

UN, 23, 24, 27, 35, 36, 37, 54, 55, 56, 83, 85, 95, 105
Unemployment, 9, 29, 30, 31, 34, 63, 92, 93, 94, 95
UNEP, 21, 24, 37, 88
UNStat, 40, 50
US, USA, 29, 79, 84, 92, 94, 102

V

Varian, H., 103
Verbruggen, H., 13, 22, 39, 51, 53, 60, 61, 64, 65, 102, 105
Vollebergh, H.R.J., 51, 57, 102
Vorrink, I., 35
Vries, W.F.M. de, 29, 104, 105

W

Walters, C., 77, 104
Weak sustainability, 88, 89
Weitzman, M.L., 9, 56, 66, 67, 68, 69, 70, 72, 73, 76, 79, 80, 81, 82, 85, 100, 105
Wijers, H., 39
Wilson, E.O., 71
Wolfensohn, J., 51
World Bank, 21, 24, 37, 38, 41, 50, 51, 55, 88, 91, 99, 101, 103, 105
WWF, 21, 24, 35, 102