Workshop

Sustainability Economics

June 13–15, 2010 | Berlin, Germany

Sustainability Economics Group, *Leuphana University of Lüneburg, Germany*
Synthesis Research Economics for Sustainability, Helmholtz Centre for Environmental Research – UFZ, Germany

Background

The vision of sustainability aims at *justice* concerning the opportunities of employing natural resources, goods and services for the satisfaction of human needs and wants. This includes *intergenerational* as well as *intragenerational* justice. - Economics, in the modern interpretation of the term, aims at *efficiency*, that is non-wastefulness, in the use of scarce resources.

There is a widespread and increasing feeling among both economists and society at large that economics should address issues of *sustainability* in the way how humans act towards nature and how they are responsible towards one another and future generations. While there are individual contributions of some economists to the discussion of specific aspects of sustainability, so far neither a unifying idea (notion, concept) nor concrete structures (scientific community, institutions, curricula, conferences, etc.) of something like *sustainability economics* do exist – at least not to any significant extent.

Interpreting currently existing economic contributions in view of the overall idea of sustainability, one could argue that the emerging field of sustainability economics can be defined by four core attributes:

1. Subject focus on the relationships between humans and nature.
2. Orientation towards the long-term and inherently uncertain future.
3. Normative foundation in the idea of justice, between humans of current and future generations as well as between humans and nature.
4. Concern for economic efficiency, understood as non-wastefulness, in the allocation of natural goods and services, their human-made substitutes and complements, and human resources such as labour or knowledge.

Aims and Scope of the Workshop

Against this background, the workshop aims at a discussion of the question: “What is sustainability economics?”, or better: “What could sustainability economics be?”, and “What should it be?”

The aims of the workshop are threefold:

1. To identify unifying and defining characteristics of sustainability economics, starting from the preliminary definition given above.
2. To propose conceptual frameworks for, and to probe components of, sustainability economics.
3. To identify key research questions and research needs, as well as to explore fruitful research perspectives for sustainability economics.

The workshop brings together a small and focused group of approximately 25 participants, including ten invited speakers, in a stimulating environment for an intensive and fruitful discussion.

Confirmed Speakers

Geir B. Asheim	University of Oslo, Norway
Lucas Bretschger	ETH Zurich, Switzerland
Geoffrey Heal	Columbia University, USA
Richard B. Howarth	Dartmouth College, USA
Ann Kinzig	Arizona State University, USA
Frank Krysiak	University of Basel, Switzerland
Charles A. Perrings	Arizona State University, USA
John Roemer	Yale University, USA
Jeroen C.J.M. van den Bergh	Autonomous University of Barcelona, Spain
Arild Vatn	Norwegian University of Life Sciences, As, Norway

Venue

The workshop will take place at the office of the Helmholtz Association in the centre of the German capital Berlin, at the bank of the river Spree. The conference location in the historical heart of the city, next to the Berlin Cathedral and Museum Island, provides a friendly atmosphere and a unique environment which should build the basis to stimulate fruitful discussions and productive research.

Accommodation is arranged at one of Berlin's most exiting hotels: The "park inn Berlin-Alexanderplatz" (http://www.parkinn-berlin.de/default-en.html).

Program

Sunday, June 13, 2010

till 6:00 pm	arrival and check-in
6:30 pm	welcome reception
7:30 pm	dinner

Monday, June 14, 2010

morning	scientific program
afternoon	social event

Tuesday, June 15, 2010

full day	scientific program

Wednesday, June 16, 2010

till 11:00 am	check out

Hosts

The workshop is organized jointly by the *Sustainability Economics Group* of *Leuphana University of Lüneburg* (head: Stefan Baumgärtner) and the Synthesis Research group Economics for Sustainability at the *Helmholtz Centre for Environmental Research – UFZ*, Germany (head: Reimund Schwarze).

More information at: http://www.leuphana.de/seg
http://www.wi-n.org/en/index.php

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Travel Information

By plane:

The conference venue and hotel can be reached easily from Berlin's international airports Tegel (TXL) and Schönefeld (SFX) using public transport.

By train:

The most convenient railway station is Hackescher Markt, which is two stops from Berlin Central Station.

Detailed travel information will be provided later.

Acknowledgement

The workshop is funded mainly through a grant from the German Federal Ministry of Education and Research as part of the programme "Economics for Sustainability" (www.wi-n.org).

WiN Economics for Sustainability

Federal Ministry of Education and Research

Chair: Friedrich Schneider (University of Linz, Austria)

14:15–15:15	**Jeroen C.J.M. van den Bergh** (Universitat Autònoma de Barcelona): *Externality or sustainability economics?*
15:15–16:15	**Arild Vatn** (Norwegian University of Life Sciences, Aas): *Institutions for a sustainable economy*
16:15–16:45	Coffee break

Chair: Martin F. Quaas (University of Kiel)

16:45–17:45	Final discussion
17:45	Closing of scientific program
19:30	Dinner (Osteria Fiorello)

Wednesday, 16 June 2009

before 12:00	Check-out

Workshop

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Program

Sunday, 13 June 2009

from 15:00	Arrival and check-in
18:30	Welcome reception (Hotel Lobby)
19:30	Dinner (Restaurant Gugelhof)

Monday, 14 June 2009

8:45–9:15	**Welcome and Introduction** Stefan Baumgärtner and Reimund Schwarze

Chair: Wolfgang Buchholz (University of Regensburg)

9:15–10:15 **Richard B. Howarth** (Dartmouth College):
Sustainability and the economics of climatic risk

10:15–11:15 **Frank C. Krysiak** (University of Basel):
Sustainability in economic policy assessments: the example of climate change

11:15–11:45 Coffee break

11:45–12:45 **Geoffrey Heal** (Columbia University):
Uncertainty, ambiguity and climate change

12:45–14:15 Lunch break

Chair: Malte Faber (University of Heidelberg)

14:15–15:15 **Ann Kinzig** (Arizona State University):
The sustainable use of spatially and temporally distributed ecosystem services

15:15–16:15 **Charles Perrings** (Arizona State University):
Trading pathogens: the sustainability of disease management under globalization

17:30–18:30 Boat cruise on the river Spree

20:00 Workshop Dinner (Restaurant Brechts)

Tuesday, 15 June 2009

Chair: Bernd Hansjürgens (UFZ – Centre for Environmental Research, Leipzig)

9:15–10:15 **Lucas Bretschger** (ETH Zürich):
Sustainable development under seemingly unfavorable conditions

10:15–11:15 **John E. Roemer** (Yale University):
A dynamic analysis of human welfare in a warming planet

11:15–11:45 Coffee break

11:45–12:45 **Geir Asheim** (University of Oslo)
Is utility discounting compatible with sustainability and equal treatment of generations?

12:45–14:15 Lunch break

Workshop

Sustainability Economics

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Book of Abstracts

Contents

Is utility discounting compatible with sustainability and equal treatment of generations?

Geir Asheim

University of Oslo

In economic debate related to climate change, it is often claimed that utility discounting undermines sustainability and constitutes an unacceptably unfavorable treatment of future generations. Such opponents of utility discounting often suggest that a utilitarian criterion with zero discounting should be applied instead. Indeed, this is basically the intergenerational social welfare function adopted by the Stern Review.

On the other hand, there are relevant models and choice situations where discounted utilitarianism appears to outperform utilitarianism with zero discounting. One can argue that utility discounting of future generations is a means of protecting the present generation from heavy sacrifices for the sake of gains for the later generations that will be far better off.

In my presentation I will examine the claim that utility discounting contradicts equal treatment of generations and thereby undermines sustainability. I present results showing that a criterion which in important circumstances is behaviorally indistinguishable from discounted utilitarianism

- can be combined with even the strongest form for equal treatment of generations (the axiom of *strong anonymity*) and
- can be responsive to the interests of generations in the distant future.

Sustainable development under seemingly unfavorable conditions

Lucas Bretschger

ETH Zurich

We study long-run growth in a multi-sector economy with non-renewable resource use and endogenous innovations. The focus is on conditions which are usually considered as highly critical for sustainable development, such as poor input substitution and population growth. We argue that poor input substitution on the sectoral level need not be detrimental for sustainable growth. Combined with resource depletion it may foster structural change, which helps to sustain research investments. We look at the properties of the transition paths, show which sectors are predicted to survive in the long run, and discuss whether the economy approximates a steady state with or without a scale effect. The results are discussed for different market forms.

We also show under which assumptions population growth is not necessarily negative for growth but may even be necessary for obtaining a sustainable consumption level. We discuss a new type of Hartwick rule defining the conditions for a constant innovation rate with population growth. The rule does not apply to capital but to labor, the crucial input in research. Furthermore, it relates to the sectoral structure of the economy and to demographic transition. These results can be extended for the case of backstop technologies and minimum resource constraints.

A final consideration is on policies to green the economy after cyclical downturns as proposed within the framework of the “Green New Deal.” We argue that there are major differences between economic recovery and sustainability so that these proposals have to be evaluated with care.

Keywords:

sustainability, non-renewable resources, poor input substitution, technical change, population growth, Hartwick rule, Green New Deal

Uncertainty, ambiguity and climate change

Geoffrey Heal

Columbia University

Uncertainty is pervasive in analysis of climate change. How should economists allow for this? And how have they allowed for it? This paper reviews both of these questions. Economic evaluation of climate policy traditionally treats uncertainty by appealing to expected utility theory. Yet our knowledge of the impacts of climate policy may not be sufficiently high quality to justify probabilistic beliefs. In such circumstances, it has been argued that the axioms of expected utility theory may not be the correct standard of rationality. By contrast, several axiomatic frameworks have recently been proposed that account for ambiguous beliefs. In this paper, we apply static and dynamic versions of the smooth ambiguity model of Klibano et al. (2005, 2009) to climate mitigation policy. We illustrate via comparative statics the conditions under which an increase in ambiguity aversion increases the optimal level of mitigation in some simple examples. We then extend our analysis to a more realistic, dynamic setting, and adapt a well-known empirical model of the climate-economy system to show that the value of emissions abatement increases as ambiguity aversion increases. We also find that the value of abatement is more sensitive to risk aversion than it is to ambiguity aversion for the simple reason that, according to our data, the inter-model spread in average consumption growth is small relative to its mean value. However, this is an empirical question, and we show that under certain conditions ambiguity aversion can have a signicant effect on the value of abatement.

Sustainability and the economics of climatic risk

Richard B. Howarth

Environmental Studies Program, Dartmouth College

The concept of sustainability plays a key role in the evaluation of climate change policies. The United Nations Framework Convention on Climate Change, for example, calls for stabilizing greenhouse gas concentrations at a level that would prevent "dangerous anthropogenic interference" with the biophysical systems that support human flourishing. This approach is linked to a particular conception of intergenerational fairness – the premise that future generations have a right to protection against potentially catastrophic harms. This premise stems from the underlying principle that human life opportunities should be sustained from each generation to the next.

This approach, however, has proved controversial in the economics of climate change. Authors such as Nordhaus,[1] for example, argue that people's observed economic decisions suggest that they hold high rates of time preference and low degrees of risk aversion. In Nordhaus' analysis, imposing aggressive policies to stabilize climate would be inconsistent with decision-makers' revealed preferences and would thereby reduce social welfare. Nordhaus' results suggest a potential conflict between the goals of intergenerational fairness and intertemporal efficiency.

In this presentation, I will argue that Nordhaus' analysis rests on an inappropriate framing of intertemporal social choice. In particular, it abstracts away from the results of recent research on the *equity premium puzzle* – the observed fact that people accept low (~1%) rates of return on safe financial assets while demanding much higher (~6%) returns on risky assets such as stocks. Attempts to explain the equity premium puzzle suggest that people hold degrees of risk aversion that are substantially higher than those employed by Nordhaus.

To analyze the importance of this effect, I will present the results of a modeling experiment that revises Nordhaus' analysis in the following respects. First, while Nordhaus focuses on a deterministic model, the revised analysis employs Monte Carlo simulations to represent the interplay between uncertainties related to climatic risks and the underlying drivers of economic growth. This analysis allows for a fat-tailed probability distribution concerning

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[1] Nordhaus, W.D. (2008). *A Question of Balance: Economic Modeling of Global Warming*. Yale University Press.

climate sensitivity – a parameter that measures the long-run impacts of rising greenhouse gas concentrations. Second, the analysis integrates the costs and benefits of climate stabilization using a representation of preferences that is consistent with recent studies on the equity premium puzzle.

The preliminary results may be described as follows. First, implementing aggressive policies to stabilize carbon dioxide concentrations at or below 450 parts per million substantially reduces the risk that climate change will impose catastrophic impacts on future generations as mandated by the "dangerous anthropogenic interference" criterion. Second, this stabilization target is consistent with welfare maximization based on the preferences that people reveal through their decisions regarding financial risks. Because climate stabilization reduces threats to future welfare, it provides valuable insurance benefits that are not reflected in Nordhaus' calculations. Accounting for these benefits suggests that the concepts of sustainability and welfare maximization point to broadly similar policy conclusions.

The sustainable use of spatially and temporally distributed ecosystem services

Ann Kinzig

EcoSERVICES Group

School of Life Sciences, Arizona State University

Following the Millennium Ecosystem Assessment (MA 2005) it has become conventional to describe the human interest in the biophysical world in terms of a set of services that directly or indirectly contribute to human wellbeing. These comprise benefits that people exploit both directly (the provisioning and cultural services) and indirectly (the supporting and regulating services). The rapid evolution of coupled human-natural systems changes the flow of the ecosystem services both physically and in terms of their value to people. This affects the way that landscapes should be managed to meet social objectives. The problem addressed in this paper stems from the fact that the people who are the source of environmental change seldom take the effects of their actions on others into account. Particularly problematic are ecosystem services that affect people at some distance, but whose value is not reflected in the decision-making process. This is in part because there is still a lack of ecological understanding of how land-use changes in a particular location affect off-site delivery of a suite of ecosystem services. But even when these impacts are known, land managers often have little incentive to account for them; their cost is neither reflected in market prices nor in other mechanisms that would force consideration of these impacts. Indeed, understanding ecosystem service flows of this kind is identified as among the key research challenges posed by the MA (Carpenter et al. 2009).

Globalization – the closer integration of the world economic system – means that local land-use decisions are increasingly driven by market prices that do not signal the environmental cost of local land-use options (Copeland & Taylor 2009). In fact, markets do not exist for most of the off-site effects of local land-use: e.g., nutrient run-off and eutrophication, loss of genetic information, alterations in disease vectors, and contributions to regional and global climatic changes. Those effects are said to be externalities of local land-use decisions. Understanding both the nature of environmental change in a coupled system and the options for managing undesirable change requires an understanding of what these externalities are and how they can be managed. In this paper I seek to answer the following questions: **If the full array of (spatially and temporally distributed) ecosystem services delivered by specific landscapes, and the full set of (spatially and temporally distributed) beneficiaries of those services are taken into account, how should this affect**

landscape management over the expected range of conditions? **And where are ecosystem service "hot spots" located—that is, what are the ecological and social conditions that lead to the greatest divergence in local and global interests in conservation (ecosystem-service delivery) outcomes?** It is in these "hotspots" that global attention should be directed, to determine which mechanisms and institutions (if any) could create greater alignment between local and global interests in the management of ecosystem services.

A fundamental problem confronting ecologists is to understand the linkages between biodiversity, ecosystem functioning and the provision of ecosystem services. There have been a number of recent attempts to clarify the linkages between biodiversity change and ecosystem functioning (e.g., Kinzig et al. 2002; Loreau et al 2002; Hooper et al, 2005). These syntheses often, though not always, show that increasing biodiversity (usually taken to be native biodiversity) affects ecosystem functioning in a positive way. The research, however, rarely extends beyond functioning to services. An increase in certain functions related to increasing biodiversity may or may not lead to an enhancement of particular services. We therefore still do not have a clear idea of what an interest in maintaining the flow of particular ecosystem services means for the conservation of biodiversity. The problem is compounded when one recognizes that humans are often trying to manage a suite of services because people value a suite of services; the types of biodiversity that may support one service may in fact detract from others of importance. Analyses that go beyond a restricted sub-set of species or services to a broader range of services is required.

But ecosystems provide both services and disservices. In addition to the provision of foods, fuels, fibers, amenity and the like, ecosystems are also the source of many diseases and natural disasters. I use the same conceptual framework for both services and disservices, since (a) a decrease in the probability and/or intensity of a disservice is equivalent to a service, and (b) both services and disservices are affected by the way in which people interact with ecosystems.

Ecosystem services are only such to the extent that people value them. A number of studies have drawn attention to the changes in ecosystem services and the importance of quantifying the value of these changes to human societies in terrestrial (e.g. Daily, 1997), marine (e.g. Duarte, 2000) and agroecosystems (Björklund et al, 1999). One source of concern is the fact that most studies of the value of ecosystem services have focused on a single dimension of the problem only. Turner *et al* (2003) drew attention to the fact that few studies had considered the multiple functions that any ecosystem supports, and fewer still had estimated ecosystem values 'before and after' environmental changes had taken place. Most ecosystem services are the result of a complex interaction between natural cycles

operating over a wide range of space and time scales. By ignoring multiple services, and multiple scales, many valuation studies underestimate the importance of the underlying ecosystem stocks to the economy; decisions based on these underestimates will lead society to underconserve valuable resources. An identification of ecosystem service "hot spots" further requires an understanding of how values differ among different groups of people, in particular locations relative to a reference patch.

In this paper I develop a framework for determining when and under what ecological and social conditions ecosystem-service "hot spots" are likely to appear. I present summaries of the physical reach of particular ecological benefits (local to global), and the ecological configurations required to deliver each of those services, to determine which services are likely to "trade off" against each other, and on what spatiotemporal scales. I then examine the available literature on the values deriving to ecosystem services in countries differing in various attributes (e.g., percent of population laboring in agriculture, GDP, life expectancy and leading causes for loss of life), and combine these two analyses to identify several potential ecosystem-service hotspots around the world.

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Sustainability in economic policy assessments: the example of climate change

Frank C. Krysiak

Department of Business and Economics, University of Basel

For discussing what “sustainability economics” is or should become, it is either possible to start from a theoretical perspective on sustainability and economics, as for example, in Baumgärtner and Quaas (2010), or one could choose an actual policy problem in which sustainability has relevance and ask what difference sustainability has made in the economic assessment of this problem.

In this paper, I pursue the second approach. I ask what difference the concept of sustainability has made in the assessment of the costs of climate change and what difference it could make. In this way, I identify a set of critical questions to which a sustainability-focussed analysis of climate change would tend to provide different answers than the conventional efficiency-focussed approach. These questions constitute a starting point for defining how and why “sustainability economics” differs from “economics”. Furthermore, I show, with a particular example, how the inclusion of sustainability changes the results of economic assessments of climate change.

The topic of climate change is ideally suited for such an investigation, as it is an environmental problem with a long time horizon, substantial uncertainty, and strongly deviating temporal distributions of costs and benefits. Any evaluation of climate policy thus has to cope with inter- and intragenerational distribution issues and with the uncertainty implicit in predicting policy outcomes and their evaluation over a long time. Furthermore, climate change has been scientifically analyzed during a time period in which the notion of sustainability has ascended from the margins of political cognition to almost omnipresence.

Interestingly, the debate about sustainability has not much of an impact on the economic assessment of climate change. Despite frequent references to “sustainability” or “intergenerational equity”, the models and normative concepts that are used to evaluate the consequences of climate change are almost identical to the ones that would have been used 20-30 years earlier. This has changed somewhat recently, mostly due to the work of Weitzman (2007) and Gollier (2002, 2009) and the controversy about Stern (2006). However, these changes are mostly adjustment of parameters not of methods or models.

Analyzing the economic models of climate change shows that this is most likely the result of an unfortunate oversimplification. The commonly used evaluation approach cannot distinguish (a) between individuals born in the past, present, or future and (b) between the evaluation of risks and of intragenerational distribution. Problem (a) implies that the conventional evaluation approach cannot navigate between the concept of consumer sovereignty (in the sense of a "right" of an individual to choose a temporal profile of consumption according to her preferences) and intergenerational equity. Indeed, much of the contention that has arisen in the wake of the Stern Review seems to be attributable to this mingling of normative positions. Problem (b) implies that accounting for uncertainty has a plethora of unwanted side-effects.

With regard to the first problem, I show that a reasonable compromise between consumer sovereignty and intergenerational equity can be made by assuring that each individual's consumption stream is evaluated according to this individual's preferences but simultaneously requiring that all individuals are treated identically, regardless of when they are born (except, possibly, for the uncertainty of their existence). This approach leads to "social time preferences" that are close to conventional approaches in the short run but represent the intergeneration equity argument made in Stern (2006) in the long run. Using the DICE model, I show that accounting for intergenerational equity in this way can explain about half of the difference between the damages reported in Nordhaus (2008) and Stern (2006).

With regard to the second problem, I argue that sustainability requires a different approach to evaluating uncertainty than the commonly used expected utility concept, as this concept cannot constrain the downside risk that is forced upon future individuals by unmitigated climate change. Using other approaches, such as Chichilnisky (1996, 2000), Krysiak and Krysiak (2006), or Krysiak (2009), leads to a considerably altered view of climate policy in which the risk of harming future individuals has to be weighed against the risk of not pursuing projects that benefits everyone.

Altogether, this investigation shows that integrating sustainability in economic assessments of environmental problems can (a) make a substantial difference in terms of results and (b) shift the focus to problems that have hitherto been only sparsely investigated, such as the relation between consumer sovereignty and intergenerational equity or the relation between the risk of harming and the chance of helping future generations.

Keywords

Sustainability, Climate Change, Uncertainty, Discounting

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Trading pathogens: the sustainability of disease management under globalization

Charles Perrings

EcoSERVICES Group

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Globalization – the widening and deepening of international trade – has had a number of environmental consequences, of which the most significant is the dispersal of pest species in general, and pathogens in particular. Yet despite the evidence on the role of trade, transport and travel in the emergence of diseases such as H5NI (Kilpatrick *et al.*, 2006) and SARS (Li, 2005), this phenomenon has only recently begun to be analyzed (Smith *et al.*, 2008; Tatem A.J. *et al.*, 2006; Perrings *et al.*, 2010). Work to date has shown a positive relationship between the opening of new markets or trade routes and the introduction of new species, and between the growth in trade volumes (the frequency of introduction) and the probability that introduced species will establish and spread (Cassey *et al.*, 2004; Semmens *et al.*, 2004; Dalmazzone, 2000; Vila & Pujadas, 2001). The volume and direction of trade turn out to be good empirical predictors of which introduced species are likely to become invasive (Levine *et al.*, 2003; Costello, 2007), and which countries are the most likely sources of zoonoses (Pavlin B. *et al.*, 2009; Smith *et al.*, 2009).

Adapting Anderson and May's compartmental framework (Anderson & May, 1979) for the vector of susceptible, *S*, and infected hosts, *I*, I suppose that susceptible hosts (flaura or fauna) are a source of value to an importing country, and that this is the 'value at risk' from potentially invasive pathogens in an importing country. The growth of the vector of infected populations has the general form:

$$\frac{dI}{dt} = f\left(I, S, \beta\right)$$

where $f\left(I, S, \beta\right)$is the density-dependent growth of the populations infected by the set of diseases affecting the importing country, a function of *S*, *I* and the vector of transmission rates, β, corresponding to those diseases. The specific form of $f\left(I, S, \beta\right)$ reflects recovery and mortality rates associated with the different diseases. The transmission rate, β, is generally modeled as a product of two rates, a contact rate and an infection likelihood. It is treated parametrically in standard SIR epidemiological models. In this case, however, it

reflects the human activities that influence both contact and infection likelihood. That is $\beta = \beta(M,Q)$ where *M* is denotes flows – import volumes – of risk materials, and *Q* is a matrix of actions that affect the likelihood of infection. It is expected that $\beta = \beta(M,Q)$ to be increasing in *M* (but to saturate) and decreasing in *Q*.

SPS measures confer two benefits. The first is a benefit to the country itself through the damage avoided in that country. The second is a benefit to other countries through the reduction in the probability that exports to those countries will be contaminated. This makes SPS measures 'impure public goods'. They confer a non-exclusive indirect benefit on others whilst yielding a direct benefit to the provider. The problem for the relevant agency is to choose the SPS measures for all potentially invasive pathogens so as to maximize the expected present value of net benefits, *E*(*W*), from two sources: (a) exploitation of domestic resources, the stock of susceptible species, *S*, and (b) imports, *M*. The two are related by the fact that the domestic resource base may be adversely affected by the invasive pathogens that accompany imports. The problem for the importing country is to balance the costs of *preventing* pathogen emergence and the costs of pathogen emergence. In the generic model, I assume *M* is given (managers cannot change import volumes) and that *S* is affected by regulating the spread of pathogens. Suppressing time arguments and the expectation operator for clarity, the objective function takes the form:

$$\underset{Q}{Max} W = \int_{t=0}^{\infty} e^{\delta t} W\left(S, Q, M\right) dt$$

I find that if an introduced pathogen has established and spread, there will exist a positive optimal steady state (sustained) level of import risk mitigation only for 'slow growing' pathogens. If a potentially dangerous pathogen is not locally established, then the optimal steady state level of inspection and interception will be chosen such that the marginal damage avoided at current import levels will be equal to the opportunity cost of resources committed to SPS. Away from the steady state optimal SPS effort will be decreasing over time if the established population of those pathogens is 'fast-growing', and will be increasing if it is 'slow-growing'. If a pathogen is not controllable through the regulation of imports (because it is already established in the country) it will not be optimal to commit resources to SPS, while SPS effort will be greatest for species that are not yet established, but that are potentially highly damaging. Finally, the higher the volume of imports the greater the rate of pathogen dispersion and hence the growth rate of the associated infectious diseases. Since this reduces optimal investment in SPS measures, closer integration of the global economy through trade will lead to reduced international SPS effort and to the perfect mixing of the pool of pathogens.

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A dynamic analysis of human welfare in a warming planet

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Climate science indicates that climate stabilization requires low GHG emissions. Is this consistent with nondecreasing human welfare?

Our welfare index, called quality of life (QuoL), emphasizes education, knowledge, and the environment. We construct and calibrate a multigenerational model with intertemporal links provided by education, physical capital, knowledge and the environment.

We reject discounted utilitarianism and adopt, first, the Intergenerational Maximin criterion, and, second, Sustainable Growth Optimization, that maximizes the QuoL of the first generation subject to a given future rate of growth. We apply these criteria to our calibrated model via a novel algorithm inspired by the turnpike property.

The computed paths yield levels of QuoL higher than the year 2000 level for all generations. They require the doubling of the fraction of labor resources devoted to the creation of knowledge relative to the reference level, whereas the fractions of labor allocated to consumption and leisure are similar to the reference ones. On the other hand, higher growth rates require substantial increases in the fraction of labor devoted to education, together with moderate increases in the fractions of labor devoted to knowledge and the investment in physical capital.

Keywords

Quality of life, climate change, education, maximin, growth.

Externality or sustainability economics?

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A possible connection between the concepts of environmental externality and sustainability is proposed. In addition, attention is asked for several other issues relevant to "sustainability economics", namely the distinction weak/strong sustainability, spatial sustainability and sustainable trade, the formulation of sustainability policy, and the ideas of early “sustainability economists”. It is argued that both sustainability and externalities reflect a systems perspective. It is argued that definite, effective sustainability solutions require more attention to be given to other-regarding preferences and social interactions of individuals as well as to energy rebound and environmental rebound/shifting effects. The case of climate change and policy is used to illustrate particular statements. As a conclusion, a list of 20 insights and suggestions for research is offered.

Institutions for a sustainable economy

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The main challenge facing sustainability economics is to institutionally connect actions that are physically connected by necessity. Human action is interconnected through changes we make in the various biogeochemical cycles of the earth system – e.g., the carbon and nitrogen cycles. More generally, the common-pool characteristics of environmental resources e.g., space, water and air make the act of one influence the opportunities for others. The increased scale of economic activity has augmented the magnitude of these interdependencies vastly, and the perspective taken here is that we lag seriously behind regarding the process of institutionally reconnecting choices made by various separated decision units.

In its basics, the problem is rather simple. A number of decision units exists using resources with consequences going beyond the borders of each unit – interdependency. The problem is to secure that these consequences are taken into account when decisions are made. In reality the problem is, however, very challenging as the number of units is large, the effects are geographically often very widely spread, and the environmental systems with which human activities interact are very complex, involving long time lags, non-linear responses and vast uncertainties.

Moreover, the present economic system is based on continuously expanding human activity. While economic growth has been important for eradicating poverty – and still will be in many parts of the world – it seems not anymore to be able to deliver much to increased welfare in rich countries. Nevertheless, departing from this growth path seems difficult as it will threaten the very functioning of the economy. So, how can we avoid a choice between an economic and an environmental crisis?

In analyzing this I utilize institutional theory. The issue of sustainable development is from this perspective about how to coordinate conflicting interests. Hence, in developing an analytic perspective on the above problems, I first set up a taxonomy for categorizing different types of coordination problems. I distinguish between:

a) simple coordination problems

b) complex coordination problems with specific interdependency

c) complex coordination problems with generalized interdependency

A coordination problem is understood as simple if choices are independent, information problems are trivial, no side effects exist and no conflict of interest appears. The standard 'text book' market trade comes close to this description. A coordination problem is complex if actions are interdependent. In the case of specific interdependency there is interdependency between parties directly engaging with each other. Non-trivial information problems in commodity production are – as an example – often treated by moving interactions from markets to firms. Generalized interdependency concerns finally interdependencies that are indirect – e.g., spread beyond local 'neighborhoods' due to non-separable environmental processes. Sustainability issues are mainly of the latter kind.

Analyzing complex coordination problems with generalized interdependency is demanding. The idea pursued in this presentation is based on the insight that the level of conflict and the capacity to coordinate depends on the institutional structure. More specifically I discuss how institutions influence

- distribution of rights and responsibilities;
- production and distribution of information;
- costs of coordination (transaction costs);
- interests and motivational aspects

Concerning the latter, I present a synthesis of resent research on human behavior – especially experimental research – supporting the idea of plural motivations – i.e., that humans are found to act selfishly in certain settings and to cooperate in others. Which motivation or rationality dominates – individual or social/cooperative – seems to depend on the institutional structure. This insight points towards the opportunity to strengthen coordination through facilitating cooperative rationality. Nevertheless, coordination will anyway be very costly in the case of generalized interdependencies. This cost does, however, also vary with institutional structures. A set of core issues concerning how information and transaction costs are linked to institutional structures are therefore explored.

This leads finally to an evaluation of a set of generic options for facilitating human coordination in situations characterized by complex coordination problems with generalized interdependencies. First, I evaluate the present regulatory system based mainly on state *ex post* regulations. I find it to be wanting as it does not manage to change the fundamental functioning of a system foremost structured to handle simple coordination problems. Complex coordination problems with generalized interdependencies seem to demand both

increased use of hierarchical coordination and a stronger role for cooperative rationality. In that respect four alternative institutional structures are analyzed:

A. *ex ante* state regulations;

B. reforming the firm/corporation through formalized triple bottom line;

C. increased use of state property; and

D. a solution based on common property.

The dynamics of each alternative A-D is evaluated against the above four dimensions (i-iv). I find that all the above alternatives offer some options for progress, but none is found to respond adequately to all challenges. A combined set of solutions may be necessary. Various adjustments of the above solutions could also offer progress. The presentation closes by outlining areas for research that could develop the insights and options for institutional reform further.

Keywords

Institutions, interdependency, sustainable development, interests, plural motivations, coordination costs

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