Workshop in Sustainability Economics:
Intergenerational Equity and Efficiency under Uncertainty

August 4–7, 2014 | Camp Reinsehlen, Germany

Sustainability Economics Group, *Leuphana University of Lüneburg, Germany*
Environmental, Resource and Ecological Economics Group, *University of Kiel*, Germany
Chair of Public Economics, esp. Environmental Economics, University of Regensburg, Germany

Background

Policies addressing climate change should be both equitable and efficient, taking into account the substantial uncertainties in the natural and economic dynamics. The vision of sustainability requires that development paths must be equitable across and within generations, while man-made and natural resources should be allocated such that none are wasted in the pursuit of increasing well-being.

Although issues of inter- and intragenerational equity and allocative efficiency are analytically independent and have hitherto predominantly been addressed as such, how one goal is addressed has repercussions on how to deal with the other one in the design of concrete policies. On a more fundamental level, how equity and efficiency under conditions of uncertainty can be conceptualized remains an unsettled question. An answer to this question, however, is a necessary requirement for evaluating public policies on problems of intergenerational importance, such as climate change mitigation, that are entrenched with deep uncertainties.

Against this backdrop, this workshop explores how issues of intergenerational efficiency and equity can be studied in an integrated manner in view of an inherently uncertain future. In particular, it aims at developing a better understanding of the influence of different normatively founded specifications of societal objectives with regard to the intra- and intergenerational distribution of wealth and uncertainty on the estimated cost of climate change and the benefits of mitigating climate change.

The workshop will discuss in particular:

- Conceptualization of intergenerational efficiency as well as equity under uncertainty,

- Trade-offs between the different normative objectives of intra- and intergenerational equity and efficiency,

- Policy evaluation and decision-making with respect to intergenerational equity and efficiency under uncertainty

Aims and Scope

The aims of the workshop are two-fold:

(1) Taking stock of the scholarly discussion on intergenerational equity and efficiency under uncertainty;

(2) Developing new approaches and concepts for future research on intergenerational equity and efficiency under uncertainty.

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

Invited Speakers

Geir Asheim	University of Oslo, Norway
Andreas Lange	University of Hamburg, Germany
Vincent Martinet	French National Institute for Agricultural Research, France
Antony Millner	Grantham Research Institute on Climate Change and the Environment (LSE), UK
Paolo G. Piacquadio	University of Oslo, Norway
Ralph Winkler	University of Bern, Switzerland
Stéphane Zuber	Paris School of Economics; CNRS, France

Venue

The workshop will take place at the conference guest house Camp Reinsehlen in the heart of the Lüneburg Heath, a short hour from Hamburg. The quietness and colorful vastness of its traditionally conserved landscape provides a peaceful atmosphere and re-creational environment which should build the basis to stimulate fruitful discussions and productive research. The guest house's philosophy to live in harmony with nature and among each other, which serves the topic of the event, is furthered by the cheerful atmosphere and the celebration of the deliberate and exquisite slow food concept. Last not least, the heathlands are a nice example for a strongly coupled ecological–economic system.

http://www.campreinsehlen.de
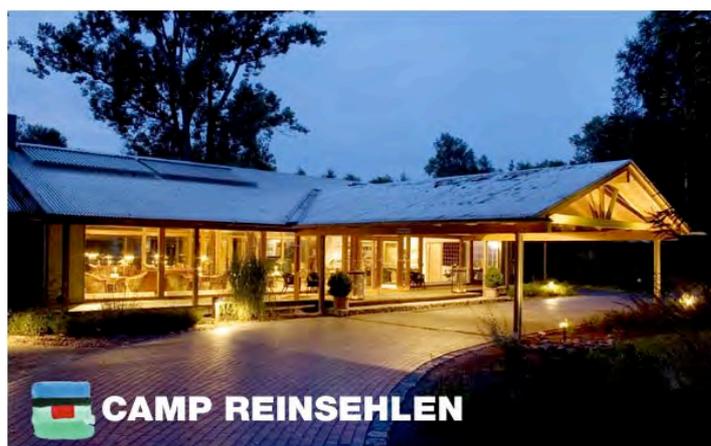
Program

Monday, August 4, 2014

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

Tuesday, August 5, 2014

full day	scientific program

Wednesday, August 6, 2014

full day	scientific program, hike in the Lüneburg Heath

Thursday, August 7, 2014

after breakfast	check-out

Hosts

The workshop is organized by the *Sustainability Economics Group* at *Leuphana University of Lüneburg* (Prof. Dr. Stefan Baumgärtner), the *Chair of Public Economics* at *University of Regensburg* (Prof. Dr. Wolfgang Buchholz) and the *Environmental, Resource and Ecological Economics Group* at *University of Kiel* (Prof. Dr. Martin F. Quaas):

http://www.leuphana.de/en/stefan-baumgaertner.html
http://www-wiwi.uni-regensburg.de/Institute/VWL/Buchholz/Home/index.html.de
http://www.eree.uni-kiel.de

Contact

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Local organizer:

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Travel Information

By plane:
The closest international airport is Hamburg (HAM). There will be a shuttle transfer from/to the airport for workshop participants.

By train:
The most convenient railway station is Wintermoor.

Detailed travel information will be provided later.

Acknowledgement

Workshop program

Intergenerational Equity and Efficiency under Uncertainty

August 4–7, 2014 | Camp Reinsehlen, Germany

Monday, 4 August 2014

from 15:00	Arrival and registration
18:00	Welcome reception (Hotel Lobby)
19:00	Dinner (Hotel Restaurant)

Tuesday, 5 August 2014

Chair: **Maik Heinemann** (University of Potsdam)　　　　　　Seminar room: "Rote Halle"

09:00-10:00	**Stefan Baumgärtner** (Leuphana University of Lüneburg), **Wolfgang Buchholz** (University of Regensburg) and **Martin F. Quaas** (Christian-Albrechts-University of Kiel): *Introduction*
10:00-11:00	**Stéphane Zuber** (PSE, CNRS) *Equity under risk and uncertainty: basic issues and extensions to an intergenerational framework*
11:00-11:30	Coffee break
11:30-12:30	**Vincent Martinet** (INRA) *Risk and intergenerational equity when the environment matters*
12:30–15:30	Lunch break, optional: Hike in the Lüneburg Heath
15:30–16:00	Coffee break
16:00–17:00	**Martin F. Quaas** (Christian-Albrechts-University of Kiel): *Peak wealth – Sustainability and substitutability in a simple solvable growth model with irreversible climate change*
17:00–18:30	Poster session: **Moritz Drupp, John-Oliver Engler, Michela Faccioli, Emmanuel S. Fianu, Martin Hänsel, A.M. Tanvir Hussain, Jasper Meya, Marie-Catherine Riekhof**
19:00	Dinner

Chair: **Johannes Bröcker** (University of Kiel)   Seminar room: "Rote Halle"

09:00–10:00   **Wolfgang Buchholz** (University of Regensburg)
The Weitzman-Gollier-puzzle: Some conceptual claims

10:00–11:00   **Antony Millner** (London School of Economics)
Resolving intertemporal conflicts: economics vs. politics

11:00–11:30   Coffee break

11:30–12:30   **Stefan Baumgärtner** (Leuphana University of Lüneburg):
Irreversibility, ignorance, and the intergenerational equity-efficiency trade-off

12:30–15:30   Lunch break,

optional: Hike in the Lüneburg Heath

15:30–16:00   Coffee Break

16:00–17:00   **Paolo G. Piacquadio** (University of Oslo)
Fair intergenerational utilitarianism: risk, its resolution over time, and discounting

17:00–18:00   **Geir B. Asheim** (University of Oslo)
Probability adjusted rank-discounted utilitarianism

18:00–18:15   Closing of workshop

19:00   Dinner

Thursday, 7 August 2014

before 11:00   Check-out

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Book of Abstracts

Contents

Probability adjusted rank-discounted utilitarianism

Geir B. Asheim[a] and Stéphane Zuber[b]

[a] Department of Economics, University of Oslo, Norway

[b] Paris School of Economics; CNRS, France

Abstract. We propose and axiomatize probability adjusted rank-discounted critical-level generalized utilitarianism (PARDCLU). We thus generalize rank-discounted utilitarianism (RDU) proposed by Zuber and Asheim (JET 147, 2012, 1572-1601) to variable population and risky situations and thereby take important steps towards preparing RDU for practical use, e.g. for evaluation of climate policies and other policy issues with long-run consequences. We illustrate how PARDCLU yields rank-dependent expected utilitarianism— but with additional structure—in a special case, and show how PARDCLU can handle a situation with positive probability of human extinction.

Available background papers:

Asheim, G.B. and S. Zuber (2014), Probability Adjusted Rank-Discounted Utilitarianism, CESifo Working Paper No. 4728. [file: Asheim_Backgroundpaper.pdf]

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Irreversibility, ignorance,
and the intergenerational equity-efficiency trade-off

Stefan Baumgärtner and Nikolai Hoberg

Sustainability Economics Group, Leuphana University of Lüneburg, Germany

Abstract. Two important policy goals in intergenerational problems are Pareto-efficiency and sustainability, i.e. intergenerational equity. We demonstrate that the pursuit of these goals is subject to an intergenerational equity-efficiency trade-off. Our analysis highlights two salient characteristics of sustainability problems and policy: (i) temporal irreversibility, i.e. the inability to revise one's past actions; and (ii) unawareness of future consequences of present actions in human-environment systems ("unknown unknowns"). If initially unknown sustainability problems become apparent and policy is enacted after irreversible actions were taken, policy-making faces a fundamental trade-off between Pareto-efficiency and sustainability.

Available background papers:

Hoberg, N. and S. Baumgärtner (2013), Irreversibility, ignorance, and the intergenerational equity-efficiency trade-off, Manuscript. [file: Baumgaertner_Backgroundpaper.pdf]

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The Weitzman-Gollier-Puzzle: Some Conceptual Claims

Wolfgang Buchholz

University of Regensburg and CESifo Munich, Germany

Abstract. In the debate around the Gollier-Weitzman puzzle the fundamental conceptual differences of both approaches mostly are not sufficiently observed. This note tries to clarify the differences of the underlying questions which to some degree makes the paradox disappear. Moreover we show that the Weitzman approach might be suitable for a situation in which sustainability is the objective of intertemporal decision-making under risk.

Available background papers:

Buchholz, W. (2014), The Weitzman-Gollier-Puzzle: Some Conceptual Claims, Manuscript. [file: Buchholz_Backgroundpaper.pdf]

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Risk and intergenerational equity when the environment matters

Vincent Martinet

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Abstract. How to assess policy options, for example in the context of climatic change, when they have uncertain economic and environmental outcomes over time? This question is a challenging one in environmental economics. It becomes even more difficult to address when intergenerational equity is required, in a sustainability perspective.

For this workshop in Sustainability Economics on Intergenerational Equity and Efficiency under Uncertainty, my presentation will focus on the way time, risk and multiple values interplay in project assessment, when the performance of dynamic systems is defined with respect to conflicting issues, such as the economy and the environment.

As a starting point, I assume that the two greatest challenges when tackling issues of sustainability are how to account for conflicting interests, such as environmental conservation and economic development, as well as for intergenerational equity (Martinet, 2012). The economic literature has come up with a variety of sustainability criteria accounting for intergenerational equity. Most of them get rid of the challenge of coping with conflicting issues by assuming the existence of a utility function, which aggregates the different sustainability issues at any time. These criteria propose different definitions of optimality and focus mainly on the intertemporal equity vs efficiency debate, with few concerns to uncertainty. In a different perspective, the viability framework defines sustainability as a requirement to satisfy a set of (environmental and economic) constraints over time. The viability approach encompasses a strong requirement for equity, both intra and intergenerational, in the sense all the viability constraints have to be satisfied at all times. There is no aggregation of the issues, and thus no way to compensate for a bad outcome on one dimension by a good outcome on another, or bad outcomes at one period by good outcomes at another. In its usual definition, viability has no concerns for efficiency and only focuses on feasibility. Viability has, however, sound connections to the maximin approach (Doyen and Martinet, 2012). It is possible to extend it towards optimality by formulating a generalized maximin problem, which defines what should be sustained for future generations (Martinet, 2011).

After a brief discussion of some sustainability criteria and their extension to the uncertainty case, I will introduce stochastic viability as a way to deal with intergenerational equity under

uncertainty when several issues are conflicting. This conceptual framework provides a way to address the trade-offs between conflicting issues and risk. It also makes it possible to rank policy options with respect to their effectiveness in satisfying viability constraints over time, a strong requirement for equity. Comparing this approach to the usual economic criteria dealing with risk and time (De Lara et al., 2014), I will describe the pros and cons of stochastic viability and build on its limits to raise new research questions. Among those is the issue of how to deal with catastrophic events, when overshooting some threshold may result in a collapse of the dynamic system. This question is very important in the climate change context in which the irreversible crossing of tipping points may have catastrophic consequences.

Keywords: Intergenerational Equity; Risk and Uncertainty; Sustainability criteria; Stochastic Viability; Indicators and Thresholds; Catastrophic event.

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Resolving intertemporal conflicts: Economics vs. Politics

Geoffrey Heal[a] and Antony Millner[b]

[b] Columbia University, USA

[b] Grantham Research Institute on Climate Change and the Environment,
London School of Economics, UK

Abstract. How should future utilities be discounted? Economists and philosophers have agonized over this question for almost a century. The choice of the pure rate of time preference has a major impact on governments' evaluations of long-run public projects, from climate policy to infrastructure investments. Yet despite the vigor, longevity, and policy importance of this debate, no consensus has emerged as to `the' appropriate value of this parameter. This paper adopts an approach, which recognizes these persistent disagreements about the rate of time preference as good-faith differences of opinion that cannot be resolved by empirical analysis alone. The problem then is to find a political process that aggregates a heterogeneous set of opinions into a single representative rate that can be used for public decision making. We examine two such mechanisms: one based on efficiency, which leads to a representative rate of time preference that declines with time, and one based on voting over optimal consumption plans, which leads to an equilibrium in which the median rate of time preference is chosen. We analyze each of these mechanisms' strengths and weaknesses, and then consider a `meta vote' between the two approaches, and find conditions under which a majority of people will prefer one to the other.

Available background papers:

Heal, G. and A. Millner (2014), Discounting the future: A political economy approach, Manuscript. [file: Millner_Backgroundpaper.pdf]

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Fair Intergenerational Utilitarianism: Risk, its Resolution over Time, and Discounting

Paolo G. Piacquadio

Department of Economics and ESOP, University of Oslo, Norway

Abstract. The paper examines the intergenerational welfare economics of risk. It studies criteria that avoid some serious drawbacks of expected utilitarianism, such as the inability to disentangle risk aversion and inequality aversion and the drastic policy recommendations in the presence of fat-tailed catastrophic events. Risk and its resolution are modeled as a decision tree: in each period, the outcome assigned to the current one-period living generation is to be traded-off against uncertain benefits of future generations; as time passes, the planner observes the realized shocks and becomes more informed about the true state of the world. The axiomatic approach singles out the family of fair intergenerational utilitarian criteria. According to such criteria, each generation's welfare is measured by a CES aggregation of the outcome at each history relative to an endogenously determined reference, called fair prospect; total welfare is the discounted sum of a CRRA transform of each generation's welfare. Depending on the magnitude of risk, on the timing of its resolution, and on the planner's risk attitude, specific discounting formulas obtain, including exponential and quasi-hyperbolic.

JEL Classification: D63; D81; H43; Q54; Q56.

Keywords: Intergenerational justice; timing of risk resolution; social ordering; discounting.

Available background papers:

Piacquadio, P.G. (2014), Fair Intergenerational Utilitarianism: Risk, its Resolution over Time, and Discounting, Manuscript. [file: Piacquadio_Backgroundpaper.pdf]

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Peak wealth – Sustainability and substitutability in a simple solvable growth model with irreversible climate change

Martin F. Quaas

Department of Economics,
Christian-Albrechts-University of Kiel, Germany

Abstract. The paper develops an analytically solvable growth model in discrete time with stocks of consumable capital, human capital, a non-renewable resource, and irreversibly accumulated greenhouse gases. The model allows for analyzing different elasticities of substitution between reproducible and non-reproducible production factors. I present a full analytical characterization of the transition dynamics for the case of less favorable substitution possibilities, showing that the optimal consumption growth rate is monotonically decreasing over time, and eventually turns negative, i.e. consumption and wealth peak after finite time. The growth rate of the optimal carbon tax is larger than the consumption growth rate and always positive. I further show that results generalize to the case of stochastic capital and resource dynamics.

Available background papers:

Quaas, M.F. (2014), Peak wealth – Sustainability and substitutability in a simple solvable growth model with irreversible climate change, Manuscript. [file: Quaas_Backgroundpaper.pdf]

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Stern vs. Nordhaus –
Lessons learned from the recent discounting debate

Ralph Winkler

University of Bern, Switzerland

Abstract. The mitigation of climate change is a prime example for a long-run project where costs and benefits are unevenly distributed over time and generations. In such an intergenerational decision context the crucial question is how to trade off costs and benefits accruing to the different generations. The most recent debate on intergenerational equity was triggered by the publication of Sir Nicolas Stern's (2007) "The Economics of Climate Change". Although using essentially the same methodology, he argued for a much more stringent and more rapid climate mitigation policy than his environmental economic peers. In this standard approach – where intertemporal social welfare is the discounted sum of the lifetime utilities of all current and future generation – the rate of pure time preference (rho) and the intertemporal elasticity of substitution (sigma) become the prime determinants for optimal intertemporal choice. This is illustrated well by Nordhaus (2007), who compares two runs of his open source integrated assessment model DICE-2007. The first run uses his preferred specifications sigma = 0.5 and rho = 1.5%. The second run employs sigma = 1 and rho = 0.1%, which are the parameter values chosen by Stern (2007). These different parameterizations cause a difference in the optimal reduction rate of emissions in the period 2010–2019 of 14% versus 53% and a difference in the optimal carbon tax of 35$ versus 360$ per ton C.

While Stern has been heavily criticized for his ad hoc parameter choice (which he justifies normatively by moral obligations towards future generations), three different lines of recent research indicate that the standard methodological approach has deficiencies that biases "optimal climate policies". First, limited substitutability between man-made and natural capital may justify more stringent GHG abatement efforts (Hoel and Sterner 2007, Sterner and Persson 2008, Traeger 2011). Second, the uncertainty of future climate damages, the potential correla- tion between climate change and economic development and, in particular, disentangling risk aversion from intertemporal elasticity of substitution induce risk averse agents to choose more stringent climate change mitigation policies (Weitzman 2007, Traeger forthcoming). Third, there is a growing concern that discounted utilitarianism is not the way we do think or should think about intergenerational social welfare. Refinements of discounted utilitarianism based on sustainability lead to a higher weight of the wellbeing of future

generations and, thus, advocate more ambitious GHG mitigation policies (Asheim and Mitra 2010, Dietz and Asheim 2012).

Despite the huge variety in methodological approaches and arguments the above mentioned literature on discounting and intergenerational equity has in common that they justify more stringent climate mitigation policies than advocated by, for example, Nordhaus (2008). It seems that Weitzman (2007) was indeed correct stating that Stern might have gotten it right for the wrong reasons. This has important implications for long and short-run climate mitigation policies.

Keywords: climate change, discounting, intergenerational social welfare, limited substitutability, Stern-Nordhaus debate, time preference, uncertainty

References:

G. Asheim and T. Mitra. Sustainability and discounted utilitarianism in models of economic growth. Mathematical Social Science, 59:148–69, 2010.

S. Dietz and G. Asheim. Climate policy under sustainable discounted utilitarianism. Journal of Environmental Economics & Management, 63:321–35, 2012.

M. Hoel and T. Sterner. Discounting and relative prices. Climatic Change, 84:265–80, 2007.

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T. Sterner and U. M. Persson. An even sterner review: Introducing relative prices into the discounting debate. Review of Environmental Economics and Policy, 2:61–76, 2008.

C. P. Traeger. Sustainability, limited substitutability and non-constant social discount rates. Journal of Environmental Economics & Management, 62:215–28, 2011.

C. P. Traeger. Why uncertainty matters – discounting under intertemporal risk aversion and ambiguity. Economic Theory, forthcoming.

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Equity under risk and uncertainty:
basic issues and extensions to an intergenerational framework

Stéphane Zuber

Paris School of Economics; CNRS, France

Abstract. I will discuss the question of equity in the context of risk and uncertainty. In particular a distinction is made between an ex ante approach (where individual welfare is assessed and compared before the realization of a risk), and an ex post approach (where individual welfare is assessed and compared after the realization of the risk). I present well-known dilemma between equity, efficiency and social rationality in this context.

I will then provide a general method for extending fair social preferences defined for riskless economic environments to the context of risk and uncertainty. It requires paying attention to individuals' risk attitudes and rationality properties of social preferences, revisiting basic ideas from Harsanyi's seminal work (Harsanyi, 1955). The social preferences that are obtained do not in general take the form of an expected utility criterion, but they always satisfy state-wise dominance. The approach can also accommodate non-expected utility individual preferences.

I will present an application of the method to the problem of catastrophic risks (in the context of climate change). I will then discuss the relevance of the approach in the context of climate change: do we then want to take into account individual risk preferences at all? Can/should we separate ex post welfare assessment and social attitudes towards risk and uncertainty? In particular, what can we do when the future may involve different (number of) people in different states of the world?

Keywords: Ex ante vs. ex post Pareto, fairness in risky situations, catastrophic risks

Available background papers:

Fleurbaey, M., and S. Zuber (2014), Discounting, beyond utilitarianism, Princeton University – William S. Dietrich II Economic Theory Center Research Paper No. 060-2014. [file: Zuber_Backgroundpaper1.pdf]

Fleurbaey, M. and S. Zuber (2014), Fair management of social risk, Documents de Travail du Centre d'Economie de la Sorbonne - 2014.16. [file: Zuber_Backgroundpaper2.pdf]

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Fudenberg, D., Levine, D.K. (2012). "Fairness, risk preferences and independence: impossibility theorems", Journal of Economic Behavior & Organization, 81, 606- 612.

Gajdos, T., Maurin, E. (2004). "Unequal Uncertainties and Uncertain Inequalities: An Axiomatic Approach", Journal of Economic Theory, 116, 93- 118.

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Millner, A. (2013). "On welfare frameworks and catastrophic climate risks", Journal of Environmental Economics and Management, 65, 310- 325.

Weitzman, M.L. (2009). "On modeling and interpreting the economics of catastrophic climate change", Review of Economics and Statistics, 91, 1- 19.

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Limits to substitution between ecosystem services and manufactured goods and intergenerational decision-making

Moritz A. Drupp[a,b]

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[b] Department of Geography and Environment,
London School of Economics and Political Science, UK

Abstract. This paper examines limits to substitution between ecosystem services and manufactured goods in consumer's utility and their implications for the evaluation of environmental policies. I provide a survey on empirical evidence regarding substitution elasticities, which are ultimately limited by subsistence requirements in the consumption of ecosystem services. I further extend the theory of dual discounting by introducing such a subsistence requirement. I find that the `relative price' of ecosystem services is non-constant and depends on the level of the consumption of ecosystem services over and above subsistence. The results suggests that the discount rate for ecosystem services should be, at present, about 1 to 5 percentage points lower compared to the rate for manufactured goods, and that the relative price of ecosystem services grows without bound as they decline towards the subsistence level. This has important implications for the management of climate change and calls for safeguarding crucial ecosystem services.

Available background papers:

Drupp, M.A. (2014), Limits to substitution between ecosystem services and manufactured goods and intergenerational decision-making, Manuscript. [file: Drupp_Backgroundpaper.pdf]

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An axiomatic approach to decision under Knightian uncertainty

John-Oliver Engler and Stefan Baumgärtner

Sustainability Economics Group, Leuphana University of Lüneburg, Germany

Abstract. Based on a set of seven axioms, we develop an original approach to decision making under Knightian uncertainty that circumvents numerous conceptual problems of existing approaches that have been brought up in the literature recently.

We understand and conceptualize Knightian uncertainty as income lotteries with known payoffs but unknown probabilities in each outcome. Against this background, we formally define the concept of uncertainty aversion and provide a proof that there exists a function H from the set of Knightian lotteries to the real numbers such that lottery f is preferred to lottery g if and only if H(f) > H(g) and that H is unique up to linear-affine transformations.

We use this result to generalize concepts from risk theory like the Arrow-Pratt measure of absolute risk-aversion to Knightian uncertainty. We propose and illustrate one possible function satisfying our axioms with a static sample decision problem and compare it to other decision rules from the literature. We find that the overall ranking of the lotteries is different from these well-known criteria, but the most preferred option coincides with the maximin rule and a pessimistic Hurwicz individual.

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Is inherent uncertainty an issue of concern in welfare estimation?

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Abstract. Environmental cost-benefit analysis (ECBA) is commonly conducted under the simplifying assumption that policies' benefits and costs are certain. However, these are characterized by uncertainties, mostly due to the complexities inherent in future ecosystems' dynamics. Thus, overlooking the presence of uncertainty can seriously affect the policy's social return if events are not as expected, this leading to poorly-informed decision-making (Pindyck 2007). Analyzing the implications of considering uncertainty in ECBA should therefore be of interest in the valuation literature.

Despite this, uncertainty only recently started to be incorporated in environmental valuation exercises (Akter and Bennett 2012). In particular, the major focus has been on knowledge or scientific uncertainty, defined as a lack of information or understanding of events and processes leading to an environmental outcome and reducible by gaining knowledge through research. However, the environmental valuation literature has overlooked another source of uncertainty, inherent uncertainty, which is due to the ordinary variability of the natural system, displays a random character and therefore is irreducible, unavoidable and unpredictable (Ascough et al. 2008).

In this framework, the purpose of our study is to examine the importance of preference analysis for decision-making in a context of inherent uncertainty. Indeed, although this latter can not be avoided or reduced, preference analysis can still play a role to help policy-makers implementing more robust and socially desirable interventions of adaptation to unpredictable events.

To answer our research question, we considered preferences for adaptation policies to global warming, characterized by great inherent uncertainty (Heal and Kriström 2002). We examined the case of S'Albufera wetland (Mallorca, Spain), where adaptation efforts will be required to avoid species losses under climatic changes. To conduct our analysis, we relied on the choice experiment technique by presenting some hypothetical management programs, showing different combinations of some policy attribute levels under global warming. In specific, the levels of one of these attributes, reflecting the number of species that could be achieved under each program, were presented as subject to a probability of global warming occurrence for a time horizon of 10 years. Different scenarios of probability

(100%, 80% and 60%) were considered to reflect inherent uncertainty and each of them was presented through a specific choice experiment to a separate representative split sample of the population. Given that the level of probability was the only element changing across the choice experiments, we compared marginal willingness to pay (MWTP) for species conservation between the scenarios to draw some conclusions on the social welfare implications of inherent uncertainty.

To enrich our analysis, we also examined respondents' risk attitude, believed to condition choices under uncertainty. To this aim, we considered an additional representative split sample displaying 50% probability and showing equal expected value for the species attribute levels as in the 100% probability scenario.

Results of the analysis showed that MWTP in the two uncertain scenarios (80% and 60% probability) is significantly different from MWTP under certainty. In specific, when global warming occurrence is uncertain, MWTP was found to be significantly higher. This outlines the relevance of the effect of inherent uncertainty on welfare. This finding was confirmed also after performing a sensitivity analysis in which MWTP in the 100%, 80% and 60% probability cases was examined under different assumptions about the policy context to check for the robustness of our conclusions. The policy context was defined by the level of some of our choice experiment's policy attributes, which were perceived by respondents as substitutes for species conservation and, consequently, affected MWTP. Results especially pointed out that, depending on the level of the substitute attributes, MWTP displayed a different sensitivity to the level of probability considered. To investigate risk attitude, MWTP under 100% and 50% probability were compared. Higher MWTP for species preservation under the uncertain case indicated a risk-loving attitude, which was found to be consistent with the results obtained from the comparison between the 100%, 80% and 60% probability scenarios.

In conclusion, our study contributes to the environmental valuation literature by highlighting the significance of the effect of inherent uncertainty on social preferences and hence the importance of taking inherent uncertainty into account in welfare analysis. Also, it offers practitioners some useful prompts for the design of valuation studies in the face of inherent uncertainty. We suggested the use of multiple scenarios of probability, as a tractable approach to describe inherent uncertainty in valuation studies. This acquires special relevance when considering that welfare measures were found to be sensitive to the level of probability considered. In addition, we pointed out some of a range of possible determinants of the effect of inherent uncertainty on welfare: risk attitude and substitute goods. Further research is though advised to shed more light on the role of these and other factors.

Keywords: social preferences, inherent uncertainty, knowledge uncertainty, environmental policy, choice experiment, climate change adaptation.

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Risk externalities, (external) moral hazard, and Insurance

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Abstract. This paper focuses on how access to a financial insurance market characterized by uncertainties in influences the allocation of resources by risk-averse agents (countries) in the economy who produce consumption goods and emits during the production process. With a constant maximum allowable emission, each country has to keep in mind the emission from the other. This paper therefore compares the endogenous choices of risk and insurance by the two countries under consideration. The issue of natural versus financial insurance has seen a great deal of exposure in a recent research; for instance, Quaas and Baumgärtner (2008). We employ a static model, which builds on Quaas and Baumgärtner (2008) by considering externality, external moral hazards and insurance. In contrast to Quaas and Baumgärtner (2008), who focus on ecosystem services, the focus of this paper is on greenhouse gas (GHG) emissions. We analyzed the allocative equilibrium and the efficiency of risk by the risk-averse agents with and without access to financial insurance. We study the policy implications for households and the society at large with varying risk preferences. Our findings show that (i) the equilibrium and efficient allocation of resources are interdependent in terms of consumption by agents present in the economy, (ii) when countries contribute to the public bad non-cooperatively in their purchase of insurance, this may lead to less pollution and to a higher welfare for each individual country. The effect on the extent of private and public good problem on welfare is determined by the properties of the utility function utilized in the modeling framework. Moreover, we study the issues of internalization of externality by the introduction of pigouvian tax into our model. Over all, the absence of financial insurance presents a situation of under/over investment in other safety measures such as self-protection and self-insurance and risk-shifting problems in the consumption of externality. Individuals would therefore invest more in other safety measures such as self-protection and self-insurance in the absence of a financial insurance and vice versa.

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Intertemporal Distribution of Well-Being in a Dynamic Integrated model of Climate and the Economy

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Abstract. The paper aims at exploring the dynamics of intertemporal distribution of well-being under alternative social objectives with regard to intertemporal distribution. Within the modelling structure of Nordhaus' latest Dynamic Integrated model of Climate and the Economy (DICE), we compare the optimal dynamics resulting under Nordhaus' objective of maximizing the discounted present value of utility to those resulting under (i) maximizing a constant level of consumption per capita path, based on Rawls'/Solow's maximin criterion, and (ii) maximizing a constant growth rate of per-capita consumption (Llavador et al., JPubE 2011).

Consumption per capita can be sustained at a level of US$ 8610 at 2005 prices, which is 25% above the 2010 Nordhaus reference value until 2310. However, this result requires early generations to save almost nothing and later generations to sacrifice large consumption quantities compared to the Nordhaus' scenario, thus 'perpetuating poverty' in a sense. In addition, the shadow price of carbon emissions is close to zero under the maximin path until 2050, and the resulting high emissions lead to atmospheric temperature increases reaching 7°C above preindustrial levels in 2310.

The maximal constant growth rate of per-capita constumption that can be sustained over 300 years is 1.22% per year. This scenario implements both weak sustainability in the sense of non-declining consumption per capita over time and a form of strong sustainability by conserving nature in terms of staying below 1.5°C atmospheric temperature increase above preindustrial levels. However, achieving the maximal constant growth rate for the entire time horizon despite future climate damage requires savings rates close to 100% until the end of the century implying heavy consumption sacrifices for the present generation.

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Willingness to pay for environmental goods under uncertainty

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Abstract. In this paper, we value benefits derived from a public environmental good under uncertainty. Most environmental goods (and ecosystem services) are non-market-traded, and benefits from such goods are typically enjoyed under conditions of uncertainty. Uncertainty can arise from several sources, such as environmental (e.g. ecosystem or climate) variability, technological development or institutional change. In this paper, we consider (binary) uncertainty in (i) consumer's income and (ii) the provision of an environmental good. We use a constant-elasticity-of-substitution (CES) utility function, where utility depends on a market good and an environmental good which is exogenously provided in a fixed quantity. The CES function is nested in a constant-relative-riskaversion form. We derive the marginal willingness to pay (WTP) for changes in (i) the probability of loss, (ii) the size of loss, and (iii) the current level of the environmental good. We also explore the comparative static properties of marginal WTP.

JEL-Classification: Q51, H22, H41

Keywords: environmental valuation, willingness to pay, uncertainty, public goods, ecosystem services, insurance

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Income inequality and willingness to pay for ecosystem services

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Abstract. We study how the distribution of income among members of society, and income inequality in particular, affects the average willingness to pay (WTP) for public ecosystem services. Our analysis is based on the model of Ebert (2003), specified with a constant-elasticity-of-substitution utility function with a private consumption good and a pure-public-good ecosystem service, extended by the assumption of log-normally distributed income.

We show that (i) average WTP for ecosystem services increases with mean household income; (ii) average WTP for ecosystem services decreases (increases) with income inequality, if ecosystem services and manufactured goods are substitutes (complements); (iii) average WTP for ecosystem services normally changes more elastically with mean household income than with income inequality, except for extreme cases.

We quantitatively estimate and illustrate our theoretical results with empirical data concerning how WTP for (1) a cultural ecosystem service in Sweden (from Broberg 2010), (2) a provisioning ecosystem service in rural China (from Wang et al. 2011), and (3) a proxy for global ecosystem services (from the meta-study of Jacobsen and Hanley 2009) depend on their respective distributions of income. Among other results we find that, on global average, ecosystem services are systematically undervalued by up to 16 per cent, if one assumes the current grossly unequal global income distribution rather than the hypothetical case of an equal distribution.

Our results are relevant in several respects. First, when doing benefit or value transfer, one should correct WTP-estimates for differences in both mean household income and income inequality. Second, when giving policy recommendations aimed at both allocative efficiency

and distributive justice, one may correct WTP-estimates for grossly unjust income inequality, and use inequality-adjusted WTP-estimates for efficiency (e.g. cost-benefit)-analysis.

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Does the Adverse Announcement Effect of Climate Policy Matter? - A Dynamic General Equilibrium Analysis

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Abstract. We quantify the welfare effect of a climate policy that is announced today, but implemented with a known time lag as political procedures impede immediate implementation. The policy is a carbon emissions tax whose time path is chosen optimally at the time when implemented. During the time span before implementation, the announcement induces a lower price of fossil fuel and thus higher emissions as compared to a no-intervention scenario. In principle, this adverse `announcement effect' could more than outweigh in welfare terms the gain from the tax after implementation. We show this not to be just a theoretical curiosity. We quantify a `window of opportunity' such that implementation before (after) its end is a welfare gain (loss) over the no-intervention scenario. The result is highly sensitive to assumptions on the resource stock which is affected with particular empirical uncertainties. Our central estimate is a window of opportunity of about 60 years. Hence, there is still time to act, but the window of opportunity may be smaller. Thus, the adverse announcement effect is a worrying phenomenon deserving political awareness. The model is a Ramsey model extended by an exhaustible carbon resource and linked to a stylized dynamic climate model adapted from the DICE-model (Norhaus 2008).

Available background papers:

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