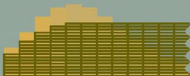


Sustainability, Economics, and Natural Resources

Justifying, Characterizing and Indicating Sustainability

By
Geir B. Asheim



 Springer

JUSTIFYING, CHARACTERIZING AND INDICATING SUSTAINABILITY

Book Series

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About the Series

An adequate economic theory of sustainability cannot be based on the neo-classical paradigm that is at the root of most sustainability issues. A new economic theory, rather than a new public policy based on the old theory, will be needed to guide humanity toward sustainability. The challenge to economists, with the help of other social scientists, is to build a new dominant economic paradigm—based on a more organic, holistic, and integrative approach. The book series *Sustainability, Economics, and Natural Resources* aims to integrate the concept of sustainability fully into economics and to provide a foundation for that new economic paradigm. The series is designed to reflect the multi- and interdisciplinary nature of the needed paradigm and will cover and integrate concepts from different streams such as agent-based modeling, behavioral economics, chaos theory, complexity theory, ecological economics, evolutionary economics, evolutionary game theory, institutional economics, post-Keynesian consumer theory, social choice theory, S-matrix theory, and quantum theory. The series will be a forum for new ideas and concepts concerning recent developments and unsolved problems in sustainability and the applications of these ideas to the policy scenario. Each volume in the series is self-contained. Together these volumes provide dramatic evidence of the range of approaches to sustainability issues found in economic thinking. The editors welcome proposals for new books in the series. Interested authors can contact the Editor-in-Chief, Shashi Kant, or the Publisher, Fabio de Castro for further details at Fabio.deCastro@Springer.com.

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Cover Figure:

A feasible sustainable stream is superimposed on the discounted utilitarian optimum in the Dasgupta-Heal-Solow model of capital accumulation and resource depletion.

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PREFACE

During the last two decades, I have subjected the concept of sustainable development to economic analysis. To a great extent this work has been done in co-operation with my co-authors Wolfgang Buchholz, Bertil Tungodden, Martin Weitzman and Cees Withagen, and it has led to a series of journal articles. This book presents the results of this research program.

The original articles are reproduced. However, I have updated information about references and corrected a few mistakes (mostly typographical).

STRUCTURE OF THE BOOK

This book consists of 19 chapters. Chapter 1 is new, written as a guide to the book and its content. It also gives an up-to-date survey of relevant literature and its relation to the later chapters.

Chapters 2–19 are reproductions of published articles. The articles are organized into three parts. Part I, which comprises Chaps. 2–7, is concerned with the normative question of how to justify sustainability. Part II, consisting of Chaps. 8–13, considers how sustainable development can be characterized. Finally, in Part III, Chaps. 14–19 are devoted to the problem of indicating sustainability. Within each part, the initial chapter – i.e., Chap. 2 for Part I, Chap. 8 for Part II and Chap. 14 for Part III – is an overview article that functions as a survey for the later chapters in the corresponding part.

NOTES ON THE HISTORY AND ORIGIN OF THE RESEARCH PROGRAM

My interest in sustainability and intergenerational justice was spurred years before I published in 1986 the first of the articles that are included in this book. I was intrigued by the following problem posed in the context of the so-called Dasgupta–Heal–Solow model of capital accumulation and resource depletion: Even under assumptions that ensure that non-decreasing streams of consumption are feasible, discounted utilitarianism forces well-being towards a zero consumption level eventually, independently of how small the positive discount rate is. It was my opinion at the time – and it still is – that this casts serious doubts on the desirability of using discounted utilitarianism as a criterion for intergenerational justice. But if not discounted utilitarianism, what criterion should be used?

Two books contributed in a significant way to the formation of my thoughts about how to trade off the opposing interests of different generations in the presence of resource constraints. First, Partha Dasgupta and Geoffrey Heal's book *Economic Theory and Exhaustible Resources* from 1979 not only presented the problem discussed in the previous paragraph, but contained a wide-ranging resource economic analysis, both from a positive and normative point of view. Second, Talbot Page's book

Conservation and Economic Efficiency from 1977 provided a thought-provoking discussion of how to manage natural and environmental resources in a manner that ensures both economic efficiency and intergenerational justice.

My two first papers on alternative normative criteria for intergenerational justice, which were written in the latter part of the 1980s and are included in this book as Chaps. 6 and 7, apply these criteria to the Dasgupta–Heal–Solow model. The newer contributions that seek to provide normative justifications for sustainability (i.e., Chaps. 2–5) have also used the Dasgupta–Heal–Solow model as an important testing ground.

In addition, two short journal articles were very influential for my work. Dixit, Hammond and Hoel's article "On Hartwick's rule for regular maximin paths of capital accumulation and resource depletion", which I first read shortly after its publication in *Review of Economic Studies* in 1980, contributed to my research in two ways. First, it spurred my interest in Hartwick's rule, describing resource management along streams with constant well-being. Hartwick's rule is the integrating concept for the different chapters of Part II, which addresses the problem of how to characterize sustainability. Second, it demonstrated to me the usefulness of the notion of competitive paths, which I have used in many of the contributions that are included here. Martin Weitzman's article "On the welfare significance of national product in a dynamic economy", published in *Quarterly Journal of Economics* in 1976, introduced me to the topic treated in the third and final part of this book: How to indicate welfare improvement and sustainability through national accounting.

ACKNOWLEDGEMENTS

I am very grateful for the insights that I have obtained through the co-operation with my co-authors, Wolfgang Buchholz, Bertil Tungodden, Martin Weitzman and Cees Withagen. Half of the articles that are reproduced in this book have been co-authored by one or more of them.

The research program has benefitted greatly from visits to Stanford University (1985–1986, sponsored by Peter Hammond, and again 2001–2002, then invited by Kenneth Arrow and Lawrence Goulder), Harvard University (2000, sponsored by Martin Weitzman), and CES, University of Munich (1994 and 1997, invited by Hans-Werner Sinn). It was a privilege to take part in lectures, seminars, and discussions during these visits, and the hospitality of these institutions are gratefully acknowledged. In particular, the interest, advice, and support of Ken Arrow and Larry Goulder during my participation in their research initiative on *the Environment, the Economy and Sustainable Welfare* during my last visit to Stanford were of great value. Seven of the 18 articles included in this book were written as part of this research initiative.

Thanks are due also to the organizers of the Ulvön Conference on Environmental Economics – in particular, Bengt Kriström – for creating an enjoyable meeting where many productive discussions on the topics of this book have taken place.

In addition to the help and input from the scholars mentioned above, I am also grateful to comments from and discussions with, among others, Thomas Aronsson,

Sir Partha Dasgupta, John Hartwick, Geoffrey Heal, Michael Hoel, Aanund Hylland, Karl-Gustav Löfgren, Karl-Göran Mäler, Tapan Mitra, Jack Pezzey, Debraj Ray and Atle Seierstad. The challenges that have been offered by journal editors, associate editors and referees are also greatly appreciated.

Finally, I am grateful to Shashi Kant for having taken the initiative to this book, to Springer for giving me the opportunity to publish it, to Esther Verdries and Fabio de Castro for editorial assistance, to Blackwell, Elsevier, the Rocky Mountain Mathematics Consortium, Springer and the Swiss Society of Economics and Statistics for permission to reproduce published articles, to CESifo in Munich, the Research Council of Norway (including several Ruhrgas grants) and the William and Flora Hewlett Foundation for financial support, and to my own institution, the Department of Economics at the University of Oslo, for providing me with working conditions that have made this project possible.

Geir B. Asheim
January 2007

FOREWORD

The concept of “sustainable development,” which is commonly termed “sustainability,” may seem new to some economists, and for others, may even be viewed as inappropriate for inclusion in economics literature. Some economists have even termed this concept as morally repugnant and logically redundant. I believe that these economists, who are not willing to accept the concept of sustainable development as an integral component of the economics profession, are still living in the twentieth century, and are not ready to move the economics profession into the twenty-first century. Such an approach toward the concept of sustainable development, and at times, to any new concept, is tragic to the profession as a whole, and will only contribute to enhancing the gap between economic theory and evidence from real life situations.

Fortunately, there is a group of economists who is committed to incorporating the concept of sustainable development into the economics profession. Geir Asheim, who has devoted his last 20 years to subjecting the concept of sustainable development to economic analysis, is among the top economists of this group. Asheim’s work on sustainability is of the highest intellect, greatest precision, and uncompromising rigor which may limit its readership to the technically well-motivated few economists who are able to see the economics profession well-beyond conventional economic efficiency theory based on discounted utilitarianism. The concept of sustainable development is a complex aspect of human welfare, and there are no simple solutions to complex problems. Geir Asheim is one of those rare economists who have realized the complexity of sustainable development, and he has analyzed three critical dimensions of sustainable development – justification, characterization, and indication – keeping the complexity in perspective. This volume is a collection of his work on all these three dimensions, and I believe that readers are fortunate to have this collection which is a premier on the economics of sustainable development.

The key characteristic of Asheim’s work is to analyze the economic implications of different assumptions and relaxing the assumptions used by other economists and himself in the analysis of sustainable development. This characteristic results in numerous economic findings which are of immense value not only to economists, but also to environmentalists, planners, policy makers, development experts, and resource managers. This volume includes a large number of such findings, and I would leave it to the readers to search for these findings throughout the pages of this volume. However, some findings discussed next are of general interest as well as of critical importance to sustainable development.

First, criteria for intergenerational equity should not only be judged by the ethical conditions on which they build, but also by their consequences in specific environments. For example, discounted utilitarianism may have appealing consequences in some technological environments but may lead to consequences indefensible from an ethical point in other environments. At the same time, there exist social preferences

over infinite utility streams that protect the interests of future generations, while retaining sensitivity for the interest of the present.

Second, under a wide set of circumstances the Hartwick rule for capital accumulation and resource depletion characterizes an efficient path with constant utility by the value of net investment being zero. This result does not even depend on substitutability between man-made and natural capital.

Third, along paths where utility is not constant, however, it is not generally true that a positive value of net investments – i.e., that accumulation of man-made capital exceeds depletion of natural capital – entails sustainability, or vice versa. Hence, the value of net investments is only an imperfect indicator of sustainability even if the vector of net investments takes into account the depletion of natural resources and degradation of environmental resources.

Finally, the different analyses in this book demonstrate that stronger results require stronger assumptions, which not only impose harder informational requirements, but stronger assumptions may not be realistic in many real-life situations. Hence, the applicability of economic results based on stronger assumption becomes limited, and it demands pluralism in economic analysis of sustainable development.

In conclusion, this volume presents a path-breaking work on economics of sustainable development. I hope, this volume will not only serve as the premier on this subject, but also motivate many more economists to move the economic profession toward the realities of the twenty-first century.

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Editor-in-Chief

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CHAPTER 1

ECONOMIC ANALYSIS OF SUSTAINABILITY

Abstract. This chapter provides a guide to the book and its chapters. It also gives a selective survey of relevant literature and its relation to the included articles.

Twenty years ago the notion of “sustainable development” was introduced into the political agenda by the World Commission on Environment and Development through its report WCED (1987), also called the Brundtland Report. The Report does not give a precise definition of “sustainable development.” The quotation that is usually taken as a point of departure is the following: “Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, p. 43). The Brundtland Report looks at sustainability both as a requirement for *intragenerational* justice and as a requirement for *intergenerational* justice.

In the contributions included in this book I (and my co-authors) limit the discussion by considering sustainability to be a requirement for *intergenerational* justice. The included articles present models where an infinite number of generations follows in sequence, and where distributional issues within each generation are *not* explicitly considered. In all but one chapter, population is assumed to be constant. In such a context sustainability requires that we, as the current generation, not use more than our fair share of the resource base. More precisely, we should manage the resource base such that the well-being that we ensure ourselves can potentially be shared by all future generations.

The notion “well-being” includes everything that influences the situation in which people live. Hence, it includes much more than material consumption. It is intended to capture the importance of health, culture, and nature. There are two important restrictions, though well-being does not include the welfare that people derive from their children’s consumption. Likewise, only nature’s instrumental value (i.e., recognized value to humans) is included in the well-being, not its intrinsic value (i.e., value in its own right regardless of human experience); i.e., an anthropocentric perspective is taken. The general rationale behind these restrictions is that there is an argument to be made in favor of distinguishing the concept of justice applied in a society from the forces that are instrumental in attaining it. In the present context this means that it may be desirable to separate the definition of sustainability from the forces that can motivate our generation to act in accordance with the requirement of sustainability.

To approach a formal sustainability definition, I follow Pezzey (1997, p. 451) in saying that development is *sustained* if the stream of well-being is nondecreasing. Using this term we can then define the concept of sustainable development as follows:

Definition 1: *A generation's management of the resource base at some point in time is sustainable if it constitutes the first part of a feasible sustained development. A stream of well-being develops in a sustainable manner if each generation's management of the resource base is sustainable.*

The idea of defining sustainability in this way corresponds closely to what is usually meant by sustainability, which “basically gets at the issue of whether or not future generations will be at least as well off as the present generation” (Krautkraemer, 1998, p. 2091). This is not the place to present a survey of the abundance of sustainability definitions; it suffices to say that the above definition is closely related to the definition of sustainability proposed by Pezzey (1997). Note that sustainability in the sense of Definition 1 does not preclude that a generation makes a large sacrifice to the benefit of future generations, so that its own well-being is lower than that of its predecessor. Hence, sustainable development is a wider concept than sustained development: While sustained development implies sustainable development, the converse implication does not hold.

Economic theories of natural and environmental resources usually seek to answer the following question: How can an efficient management of natural and environmental resources be achieved? The objective is to get the real economy to imitate a perfect market economy through internalizing external effects and to promote economic efficiency through regulating the use of natural and environmental resources when such internalization is not feasible. Traditionally, many economists have held the view that, in a perfect market economy, posterity will be made better off due to accumulation of man-made capital (including accumulation of knowledge). To the extent that the depletion of natural resources and the degradation of environmental resources have been explicitly taken into account, these economists have claimed that, due to rising resource prices and technological progress, new reserves will be added to existing resources and substitutes to these resources will be made available. A classic reference for this point of view is Barnett and Morse (1963) (see also Nordhaus, 1974).

However, in general, this view cannot be defended. At any time the present generation determines how the resource base is being managed. Given our technological capacities, it is possible to exploit the resource base to our own advantage – at the expense of the well-being of future generations. That economic efficiency does not necessarily lead to intergenerational fairness was forcefully argued by Talbot Page (1977) in his book *Conservation and Economic Efficiency*. He illustrated the issue by the following analogy: If someone suggested that the ocean fisheries in the Pacific should be regulated by giving full rights to the entire resource stock to Japan for one year, to the United States for the next, to Russia for the third year, and so forth, it would be natural to claim that the country that came first would exploit the resources to too large an extent. This skepticism would be especially great if the harvest methods were technologically advanced. Still, if we abstract from the fact that generations overlap, this is the way a perfect market economy (without market failure of any kind) allocates natural and environmental resources between the generations: Future generations' well-being depends on the altruism that we extend to them as