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Hirofumi Uzawa
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Economic Theory and Global Warming

In this book, Professor Uzawa modifies and extends the theoretical premises of orthodox economic theory to make them broad enough for analyzing the phenomena related to environmental disequilibrium – particularly global warming – and finding institutional arrangements and policy measures that may bring about a more optimal state in which the natural and institutional components are harmoniously blended. He constructs a theoretical framework in which three major global environmental issues may effectively be addressed. First, all global environmental phenomena exhibit externalities of one kind or another. Secondly, global environmental issues involve international and intergenerational equity and justice. Thirdly, global environmental issues concern the management of the atmosphere, the oceans, water, soil, and other natural resources and need to be addressed through a consensus of all affected countries.

Hirofumi Uzawa is Director of the Research Center of Social Overhead Capital at Doshisha University and Emeritus Professor of Economics at the University of Tokyo and Niigata University. In a teaching career spanning more than four decades, he has also taught at Stanford University, the University of California at Berkeley, the University of Chicago, Cambridge University, the University of Minnesota, and the University of Pennsylvania. Professor Uzawa is a Fellow and former President of the Econometric Society and a former President of the Japan Association for Economics and Econometrics. He is a Fellow of the American Academy of Arts and Sciences, a Foreign Associate of the U.S. National Academy of Sciences, a Foreign Honorary Member of the American Economic Association, and a Member of the Japan Academy.

Professor Uzawa has also been a Fellow at the Center for Advanced Study in the Behavioral Sciences at Stanford as well as an Overseas Fellow of Churchill College, Cambridge, and he has served for more than 30 years as Senior Advisor in the Research Institute of Capital Formation at the Development Bank of Japan.

Professor Uzawa has been one of the leading economic theorists of the past four decades. His contributions to economics cover virtually every branch of the field, ranging from the pure theory of consumer behavior to the duality theory of production and capital, general equilibrium theory, endogenous theory of technical progress, two-sector analysis of capital accumulation, optimal growth theory, and the theory of social overhead capital. In recent decades he has become particularly well known for applied research in the areas of the economics of pollution, environmental disruption, and global warming as well as the economics of education and medical care.

Professor Uzawa is the author of numerous articles in the world's leading economics journals and of more than twenty books, including *Preference, Production, and Capital: Selected Papers of Hirofumi Uzawa* (Cambridge University Press, 1988). Twelve volumes of his papers were collected and published in Japanese in 1994–5. He is the recipient of the Matsunaga Prize (1969), the Yoshino Prize (1970), and the Mainichi Prize (1974). The government of Japan designated him a Person of Cultural Merit in 1983, and the Emperor of Japan conferred the Order of Culture upon him in 1997.

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PUBLISHED BY THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE
 The Pitt Building, Trumpington Street, Cambridge, United Kingdom

CAMBRIDGE UNIVERSITY PRESS
 The Edinburgh Building, Cambridge CB2 2RU, UK
 40 West 20th Street, New York, NY 10011-4211, USA
 477 Williamstown Road, Port Melbourne, VIC 3207, Australia
 Ruiz de Alarcón 13, 28014 Madrid, Spain
 Dock House, The Waterfront, Cape Town 8001, South Africa

<http://www.cambridge.org>

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First published 2003

Printed in the United Kingdom at the University Press, Cambridge

Typeface Times Ten 10/13.5 pt. *System* L^AT_EX 2_ε [TB]

A catalog record for this book is available from the British Library.

Library of Congress Cataloging in Publication Data

Uzawa, Hirofumi, 1928–

Economic theory and global warming / Hirofumi Uzawa.

p. cm.

Includes bibliographical references and index.

ISBN 0-521-82386-2

1. Air–Pollution–Economic aspects. 2. Global warming–Mathematical models.
3. Equilibrium (Economics) 4. Economics, Mathematical. I. Title.

HC79.A4U93 2003

363.738/74 – dc21 2002042901

ISBN 0 521 82386 2 hardback

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Preface

The unremitting processes of industrialization and urbanization in the last several decades have disrupted and destabilized the global environment to a degree unprecedented in the history of mankind. Not only have global environmental issues such as global warming, acid rain, the loss of biodiversity, pollution of the oceans, and desertification become real threats to the stability of the environmental equilibrium, but they also tend to impair economic development in many developing countries and to lower the welfare of people in all future generations decisively.

The processes by which global environmental issues have arisen are interwoven with natural, historical, cultural, social, and political factors, but the predominant forces behind them are economic. Any analysis of environmental issues must involve a careful examination of the economic motives behind the activities responsible for the disruption of the natural environment, and any institutional arrangements or policy measures intended to restore environmental equilibrium must take into account the resulting economic impact on human activities.

Global environmental issues have three aspects that have not been satisfactorily addressed by orthodox economic theory until quite recently.

First, all phenomena involved with global environmental issues exhibit externalities of one kind or another. That is, as is typical with the case of global warming, what each individual decides to do is affected by the behavior of other members of the society, and vice versa.

The questions of externalities certainly are of great interest to the economist as exemplified by Cecil Pigou's classic work *The Economics of Welfare* (Pigou 1925) and Paul Samuelson's seminal paper, "The Pure Theory of Public Expenditures" (Samuelson 1954). However, externalities had been regarded as exceptional and put aside as something of an anomaly until the problems of environmental disruption became one of the focal issues in economic theory.

Secondly, global environmental issues involve international and intergenerational equity and justice. Although global environmental issues arise chiefly as the result of economic activities in developed countries, it is the people in developing countries who have to bear the burden. By the same token, the current generation may enjoy spurious benefits from the economic activities that cause environmental disruption, but it is the people in all future generations who will suffer from the consequences of the current generation's economic activities. The problems of equity and justice were among the focuses of classical economists such as Adam Smith and John Stuart Mill. However, the classical and neoclassical economists failed to construct the theoretical framework in which problems related to equity and justice can be examined satisfactorily. It was only in 1951, when Kenneth Arrow's seminal work, *Social Choice and Individual Values* was published (Arrow 1951), that the problems of equity and justice were congruently discussed.

Thirdly, global environmental issues concern the management of the atmosphere, the oceans, water, soil, and other natural resources and must therefore be addressed by the consensus of all the countries involved. Traditional economic theory primarily concerns the working of a competitive market system in which the allocation of scarce resources and the distribution of incomes are largely determined by price mechanism. The recent development of game theory, however, enables us to examine in detail the more general circumstances under which several individuals or countries are involved in conflicting activities and a set of definite rules and binding constraints are observed. Global environmental issues are precisely the problems to which the conceptual framework and analytical apparatuses of game theory may be applied effectively.

The present study is an offshoot of my attempt to modify and extend the theoretical premises of orthodox economic theory to make

them broad enough to analyze the phenomena of environmental disequilibrium, particularly global warming, and to find the institutional arrangements and policy measures that will bring about the optimum state of affairs in which the natural and institutional components are blended together harmoniously to realize the idealistic stationary state, or the sustainable state if I use the terminology fashionable today, as eloquently prophesied by John Stuart Mill in his classic *Principles of Political Economy* (Mill 1848). I have particularly endeavored to construct a theoretical framework in which the three major problems relating global environmental issues just described may be answered effectively. However, the problems identified here have turned out to be much more difficult than I originally anticipated. This book, therefore, presents the results of my endeavor, albeit in a very preliminary stage, in a form that may be accessible to colleagues and students interested in environmental economics as well as in economic theory in general. Each chapter is presented in such a manner, occasionally at the risk of repetition, that it may be read without knowledge of other chapters. I wish that young economists with competent analytical skill and deep concern with the welfare of future generations will follow the lead suggested and develop a full-fledged theory of the global environment with particular reference to global warming.

Most of the work for this study was done at the Beijer Institute of Ecological Economics in the Royal Swedish Academy of Sciences. I would like to express my sincerest gratitude to Karl-Göran Mäler, Director of the Institute, and the Institute staff for the intellectual stimuli and generous hospitality they have extended to me at the Institute.

I would like to acknowledge with gratitude the valuable comments and suggestions made by several economists as well as researchers specializing in earth sciences. They are too numerous to cite here, but I would like to name a few among them: Kenneth J. Arrow, Kazumi Asako, Partha Dasgupta, Yuko Hosoda, Dale W. Jorgenson, Morio Kuninori, Mohan Munasinghe, Robert M. Solow, and Katsuhisa Uchiyama. I would also like to thank the readers of the original manuscript, who made thoughtful and detailed comments and suggestions.

Generous support, financial and otherwise, from the Japanese Ministry of Education and Science, the Japan Academy, the Development

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Bank of Japan, the Asahi Glass Foundation, and the Nissan Foundation for the Advancement of Science is gratefully acknowledged.

Finally, but not the least, I would like to acknowledge with gratitude the patience and encouragement that my wife, Hiroko, and other members of my family have extended to me while I have been engaged in the study and research of economic theory in general and global warming in particular during the last 40 years.