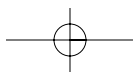


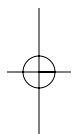
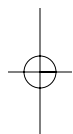
# A QUESTION OF BALANCE

WEIGHING THE  
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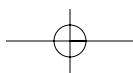
**WILLIAM NORDHAUS**

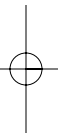
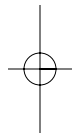
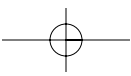


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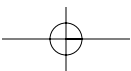


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# A Question of Balance

Weighing the Options on  
Global Warming Policies

William Nordhaus

Yale University Press New Haven & London

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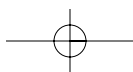
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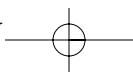
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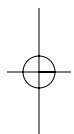
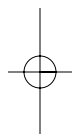
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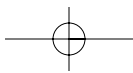


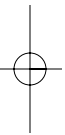
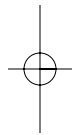
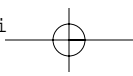
*Simplicity is the highest form of sophistication.*

—Leonardo

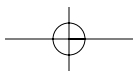


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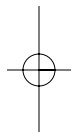
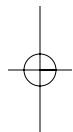


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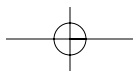
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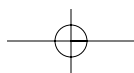
## Acknowledgments

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In October 2007, the Nobel Peace Prize was awarded to the Intergovernmental Panel on Climate Change (IPCC) and Albert Gore Jr. “for their efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change.” This award highlights the importance and complexity of the scientific, social, environmental, and policy issues involved in global warming. The present work is deeply indebted to the extraordinary contributions of social and natural scientists working in this area. The author has benefited from the fundamental research of an earlier generation of researchers, notably Tjalling Koopmans, Lester Machta, Alan Manne, Howard Raiffa, Roger Ravelle, Thomas Schelling, Joseph Smagorinsky, Robert Solow, and James Tobin, as well as dozens of friends and colleagues who have contributed to the four assessment reports of the IPCC. To paraphrase Newton, if I have seen anything, it is by standing on the shoulders of giants. Therefore, it is to the giants of the past and to the current generation of social and natural scientists working on global warming that this book is dedicated.



## Introduction

The issues involved in understanding global warming and taking actions to slow its harmful impacts are the major environmental challenge of the modern age. Global warming poses a unique mix of problems that arise from the fact that global warming is a global public good, is likely to be costly to slow or prevent, has daunting scientific and economic uncertainties, and will cast a shadow over the globe for decades, perhaps even centuries, to come.

The challenge of coping with global warming is particularly difficult because it spans many disciplines and parts of society. Ecologists may see it as a threat to ecosystems, marine biologists as a problem leading to ocean acidification, utilities as a debit on their balance sheets, and coal miners as an existential threat to their livelihood. Businesses may view global warming as either an opportunity or a hazard, politicians as a great issue as long as they do not need to mention taxes, ski resorts as a mortal danger to their already-short seasons, golfers as a boon to year-round recreation, and poor countries as a threat to their farmers, as well as a source of financial and technological aid. This multifaceted nature also poses a challenge to natural and social scientists, who must incorporate a wide



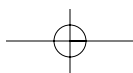
variety of geophysical, economic, and political disciplines into their diagnoses and prescriptions.

This is the age of global warming—and of global-warming studies. This book uses the tools of economics and mathematical modeling to analyze efficient and inefficient approaches to slowing global warming. It describes a small but comprehensive model of the economy and climate called the DICE-2007 model, for Dynamic Integrated model of Climate and the Economy.

This book reports on a completely revised version of earlier models developed by the author and collaborators to understand the economic and environmental dynamics of alternative approaches to slowing global warming. It represents the fifth major version of modeling efforts, with earlier versions developed in the periods 1974–1979, 1980–1982, 1990–1994, and 1997–2000.<sup>1</sup> Many of the equations and details have changed during the different generations, but the basic modeling philosophy remains unchanged: to incorporate the latest economic and scientific knowledge and to capture the major elements of the economics of climate change in as simple and transparent a fashion as possible. The guiding philosophy is, in Leonardo’s words, that “simplicity is the highest form of sophistication.”

The book combines a description of the new version of the DICE model with analyses of several major issues and policy proposals. We begin with a brief outline of the major chapters for those who would like a map of the terrain.

Chapter 1 is a “Summary for the Concerned Citizen” that describes the underlying approach and major results of the study. This chapter stands alone and can usefully be read by noneconomists who want a broad overview, as well as by specialists who would like an intuitive summary.



Chapter 2 provides a verbal description of the DICE model. Chapter 3 provides a detailed description of the model's equations. The actual equations of the model are presented in the Appendix.

Chapter 4 describes the alternative policies that are analyzed in the computer runs. These include everything from the current Kyoto Protocol to an idealized perfectly efficient or "optimal" economic approach. Chapter 5 presents the major analytical results of the different policies, including the economic impacts, the carbon prices and control rates, and the effects on greenhouse-gas concentrations and temperature.

Chapters 6 through 9 provide further analyses using the DICE model. Chapter 6 begins with an analysis of the impacts of incomplete participation. This new modeling approach is able to capture analytically the economic and geophysical impacts of policies that include only a fraction of countries or sectors; it shows the importance of full participation. Chapter 7 presents preliminary results on the impacts of uncertainty on policies and outcomes. Chapter 8 is a policy-oriented chapter that examines the two major approaches to controlling emissions—prices and quantities—and describes the surprising advantages of price-type approaches.

Chapter 9 provides an analysis, using the DICE-model framework, of the recent *Stern Review* of the economics of climate change. The final chapter contains some reservations about the results and then presents the major conclusions of the study. The GAMS computer code, the derivation of the model, and technical details are provided in "Accompanying Notes and Documentation on Development of DICE-2007 Model" (Nordhaus 2007a). The Web site for the DICE model and results is <http://www.econ.yale.edu/~nordhaus/homepage/DICE2007.htm>.