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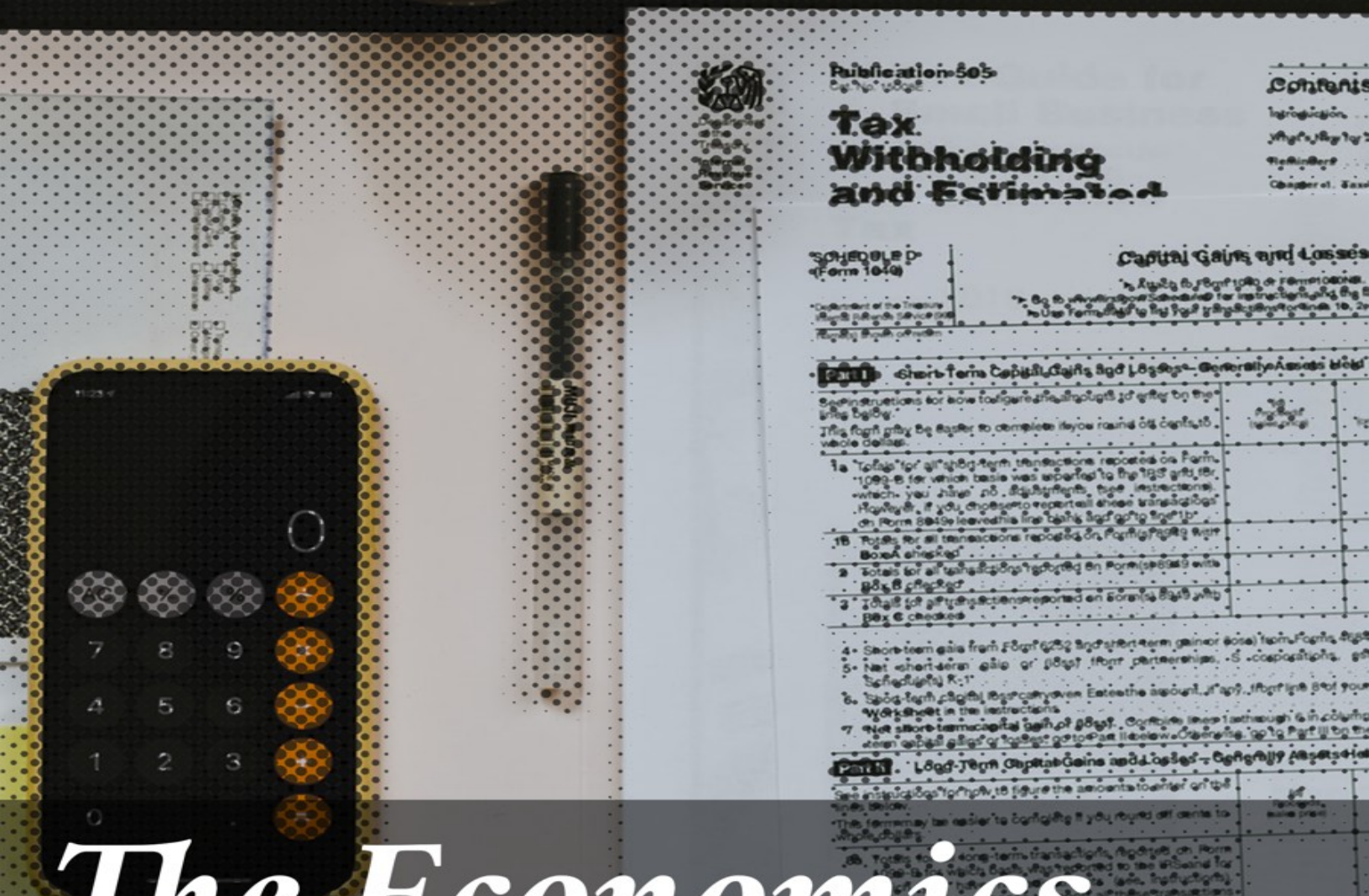

The Economics of Climate Change: a Primer

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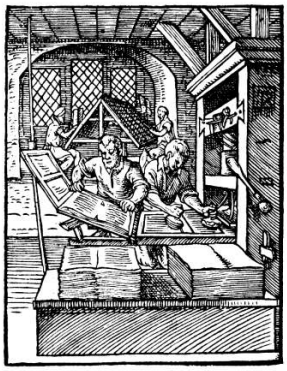

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Preface

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A scientific consensus is emerging that rising atmospheric concentrations of greenhouse gases are gradually changing the Earth's climate, although the magnitude, timing, and effects of the alteration remain very uncertain. The prospect of long-term climate change raises a variety of domestic and international economic policy issues on which there is little accord. Considerable disagreement exists about whether to control greenhouse gas emissions, and if so, how and by how much; and whether to coordinate climate-related polices at the international level, and if so, through what mechanisms.

This Congressional Budget Office (CBO) study—prepared at the request of the Ranking Member of the House Committee on Science—presents an overview of issues related to climate change, focusing primarily on its economic aspects. The study draws from numerous published sources to summarize the current state of climate science and provide a conceptual framework for addressing climate change as an economic problem. It also examines public policy options and discusses the potential complications and benefits of international coordination. In keeping with CBO's mandate to provide impartial analysis, the study makes no recommendations.

Robert Shackleton of CBO's Macroeconomic Analysis Division wrote the study. CBO staff members Robert Dennis, Terry Dinan, Douglas Hamilton, Roger Hitchner,

Arlene Holen, Kim Kowalewski, Mark Lasky, Deborah Lucas, David Moore, John Sturrock, Natalie Tawil, and Thomas Woodward provided valuable comments and assistance, as did Henry Jacoby of the Massachusetts Institute of Technology and Thomas Schelling of the University of Maryland at College Park. The comments of Chris Webster and John Reilly of the Massachusetts Institute of Technology and Mort Webster of the University of North Carolina at Chapel Hill were particularly helpful in developing the discussion of uncertainty.

Leah Mazade edited the study, and Christine Bogusz proofread it. Kathryn Winstead prepared the study for publication, and Annette Kalicki produced the electronic versions for CBO's Web site.

Douglas Holtz-Eakin
Director

April 2003

Summary and Introduction

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Human activities—mainly deforestation and the burning of fossil fuels—are releasing large quantities of what are commonly known as greenhouse gases. The accumulation of those gases is changing the composition of the atmosphere and is probably contributing to a gradual warming of the Earth's climate—the characteristic weather conditions that prevail in various regions of the world. Scientists generally agree that continued population growth and economic development over the next century will result in substantially more greenhouse gas emissions and further warming unless measures are taken to constrain those emissions.

Despite the general consensus that some amount of warming is highly likely, extensive scientific and economic uncertainty makes predicting and evaluating its effects extremely difficult. Because climate is generally a regional phenomenon, the effects of warming would vary by region. Moreover, some effects could be positive and some negative. Some could be relatively minor and some severe in their impact: warming could raise sea levels; expand the potential range of tropical diseases; disrupt agriculture, forestry, and natural ecosystems; and increase the variability and extremes of regional weather. There is also some possibility of unexpected, abrupt shifts in climate. Actual outcomes will probably be somewhere in the middle

of the range of possibilities, but the longer that emissions grow unchecked, the larger the effects are likely to be.

A variety of technological options are available to restrain the growth of emissions, including improvements in the efficiency of people's use of fossil energy, alternative energy technologies such as nuclear or renewable power, methods for removing greenhouse gases from smokestacks, and approaches to sequestering gases in forests, soils, and oceans. But those alternatives are likely to be costly, and they are unlikely to be widely implemented unless measures are taken to lower their price or to raise the price of greenhouse gas emissions.

This Congressional Budget Office (CBO) study presents an overview of the issue of climate change, focusing primarily on its economic aspects. The study draws from many published sources to summarize the current state of climate science. It also provides a conceptual framework for considering climate change as an economic problem, examines public policies and the trade-offs among them, and discusses the potential complications and benefits of international coordination.

Common Resources: Addressing a Market Failure

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The Earth's atmosphere is a global, open-access resource that no one owns, that everyone depends on, and that absorbs emissions from an enormous variety of natural and human activities. As such, it is vulnerable to overuse, and the climate is vulnerable to degradation—a problem

known as the tragedy of the commons. The atmosphere's global nature makes it very difficult for communities and nations to agree on and enforce individual rights to and responsibilities for its use.

With rights and responsibilities difficult to delineate and agreements a challenge to reach, markets may not develop to allocate atmospheric resources effectively. It may therefore fall to governments to develop alternative policies for addressing the risks from climate change. And because the causes and consequences of such change are global, effective policies will probably require extensive cooperation among countries with very different circumstances and interests.

However, governments may also fail to allocate resources effectively, and international cooperation will be extremely hard to achieve as well. Developed countries, which are responsible for the overwhelming bulk of emissions, will be reluctant to take on increasingly expensive unilateral commitments while there are inexpensive opportunities to constrain emissions in developing countries. But developing nations, which are expected to be the chief source of emissions growth in the future, will also be reluctant to adopt policies that constrain emissions and thereby limit their potential for economic growth—particularly when they have contributed so little to the historical rise in atmospheric greenhouse gas concentrations and may suffer disproportionately more of the negative effects if nothing is done.

Balancing Competing Uses

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The atmosphere and climate are part of the stock of natural resources available to people to satisfy their needs and wants over time. From an economic point of view, climate policy involves measuring and comparing the values that people place on resources, across alternative uses and at different points in time, and applying the results to choose a course of action. An effective policy would balance the benefits and costs of using the atmosphere and distribute those benefits and costs among people in an acceptable way.

Uncertainty about the scientific aspects of climate change and about its potential effects complicates the challenge of developing policy by making it difficult to estimate or balance the costs of restricting greenhouse gas emissions and the benefits of averting climate change. (Some of the risks involved, moreover, may be effectively impossible to evaluate or balance in pecuniary terms.) Nevertheless, assessments of the potential costs and benefits of a warming climate typically conclude that the continued growth of emissions could ultimately cause extensive physical and economic damage. Many studies indicate significant benefits from undertaking research to better understand the processes and economic effects of climate change and to discover and develop new and better technologies to reduce or eliminate greenhouse gas emissions.

At the same time, such studies typically find relatively small net benefits from acting to reduce greenhouse gas emissions in the near term. In balancing alternative investments, they conclude that if modest restrictions on

emissions were implemented today, they would yield net benefits in the future; however, more-extensive restrictions would crowd out other types of investment, reducing the rate of economic growth and affecting current and future generations' material prosperity even more than the averted change would. As income and wealth grow and technology improves, the studies say, future generations are likely to find it easier to adapt to the effects of a changing climate and to gradually impose increasingly strict restraints on emissions to avoid further alteration.

Those conclusions greatly depend, among other things, on how one balances the welfare of current generations against that of future generations. In assessments of costs and benefits occurring at different points in time, that process of weighting is typically achieved by using an interest, or discount, rate to convert future values to present ones. But there is little agreement about how to discount costs and benefits over the long time horizons involved in analyzing climate change.

Whatever weighting scheme is chosen, consistency calls for applying it to all long-term investment alternatives. For example, applying a lower discount rate to give more weight to the welfare of future generations implies that society should reduce its current consumption and increase its overall rate of investment in productive physical and human capital of all kinds—not only those involved in ensuring a beneficial future climate.

Government policies that deal with use of the atmosphere inevitably affect the distribution of resources. Inaction benefits people who are alive today while

potentially harming future generations. Reducing emissions now may benefit future generations while imposing costs on the current population and may benefit countries at relatively higher risk of adverse effects from warming while hurting those that stand to gain from it. Restraints on emissions would impose costs on nearly everyone in the global economy, but they would affect energy-producing and energy-intensive industries, regions, and countries much more than they would others. However, many studies of the costs and benefits of climate change fail to highlight the extent to which differences in geographic and economic circumstances complicate the balancing of interests.

Policy Options

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Governments may respond to climate change by adopting a "wait-and-see" approach, by pursuing research programs to improve scientific knowledge and develop technological options, by regulating greenhouse gas emissions, or by engaging in a combination of research and regulation. The United States has invested in research and subsidized the development of carbon-removal and alternative energy technologies. Furthermore, some programs that were in tended to achieve other goals, such as pollution reduction, energy independence, and the limitation of soil erosion, also discourage emissions or encourage the removal of greenhouse gases from the atmosphere. However, other programs have opposing effects.

Should a government decide to control emissions, it may choose from a broad menu of regulatory approaches. One option is direct controls, which set emissions standards for equipment and processes, require households and businesses to use specific types of equipment, or prohibit them from using others. A government could also adopt more indirect, incentive-based approaches, either singly or in combination—for example, by restricting overall quantities of emissions through a system of permits or by raising the price of emissions through fees or taxes. Incentive based approaches are generally more cost-effective than direct controls as a means of regulating greenhouse gas emissions.

Uncertainty about the costs and benefits of regulation affects the relative advantages of different incentive-based approaches. Some research indicates that such uncertainty gives a system of emissions pricing economic advantages over a quota system that fixes the quantity of emissions. Those advantages stem from two facts: both the costs and benefits of reducing greenhouse gas emissions are uncertain; and the incremental costs—the additional costs of reducing an additional ton of emissions—can be expected to rise much faster than the incremental benefits fall. Under those circumstances, the cost of guessing wrong about the appropriate level of taxes—and, perhaps, of failing to reduce emissions enough in any given year—is likely to be fairly low. But the cost of miscalculating the appropriate level of emissions—and perhaps imposing an overly restrictive and hence expensive limit—could be quite high.

A system of emissions pricing has several other advantages over one of emissions quotas. Pricing could raise significant revenues that could be used to finance cuts in distortionary taxes—such as those on income—that discourage work and investment. Moreover, emissions pricing more effectively encourages the development of technologies that reduce or eliminate emissions than direct controls or strict limits on emissions do.

Restricting greenhouse gas emissions would tend to reduce emissions of some conventional pollutants as well, yielding a variety of ancillary benefits, such as improvements in health from better-quality air and water. Those additional benefits would partly offset the costs of greenhouse gas regulations, particularly in developing countries that have significant problems with local pollution.

The distributional effects of emissions regulations would depend on the type and stringency of the regulations and could be very large relative to how much the policy improved people's well-being. Those potential effects might spur the affected parties to engage in rent-seeking—vying for regulatory provisions that would provide them with tax exemptions, access to permits, and so on. An emissions pricing system (based either on taxes or on auctioned permits) would benefit different groups in different ways, depending on how the government returned the receipts to the economy. Certain ways of using the revenues could offset some—but probably not all—of the costs of regulation. (For example, if the government issued permits