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Addressing the Uncertain Prospect of Climate Change

Over the next century, human activities will produce large quantities of greenhouse gases, and their accumulation in the atmosphere is expected to affect regional climates throughout the world. Those effects are very uncertain yet could prove serious and costly in at least some regions. However, restraints on emissions would also be costly and could be difficult to achieve in an efficient manner.

The atmosphere is freely available to all, and greenhouse gases spread around the world no matter where they are emitted. Those characteristics make it very difficult to create property rights and markets for use of the atmosphere—and they make the climate issue international in scope. It may therefore fall to governments to develop alternative policies for addressing the risks posed by climate change.

An effective policy response to those risks is likely to involve a series of actions based on incomplete but accumulating knowledge. Continued research could help guide policymakers by improving understanding of the risks and by developing options for reducing them. Modest restrictions on emissions—particularly restrictions that raised the price of emissions—could also yield net benefits, but extensive controls could crowd out other investments and reduce future generations' prosperity.

The balancing of costs and benefits will be complicated by conflicts of interest—between energy-producing and energy-using regions, developed and developing countries, regions that may benefit from warming and others that stand to lose from it, and current and future generations. The challenge will be to develop policies that take advantage of low-cost opportunities to reduce emissions throughout the world, and to find an acceptable way to distribute costs and benefits among countries and regions with dramatically different circumstances and interests.

A variety of human activities—mainly deforestation and the burning of fossil fuels—are adding greenhouse gases to the Earth's atmosphere and are probably contributing to a gradual warming of its climate. Unless measures are taken to constrain them, such emissions will continue to increase and the climate is likely to continue to warm.

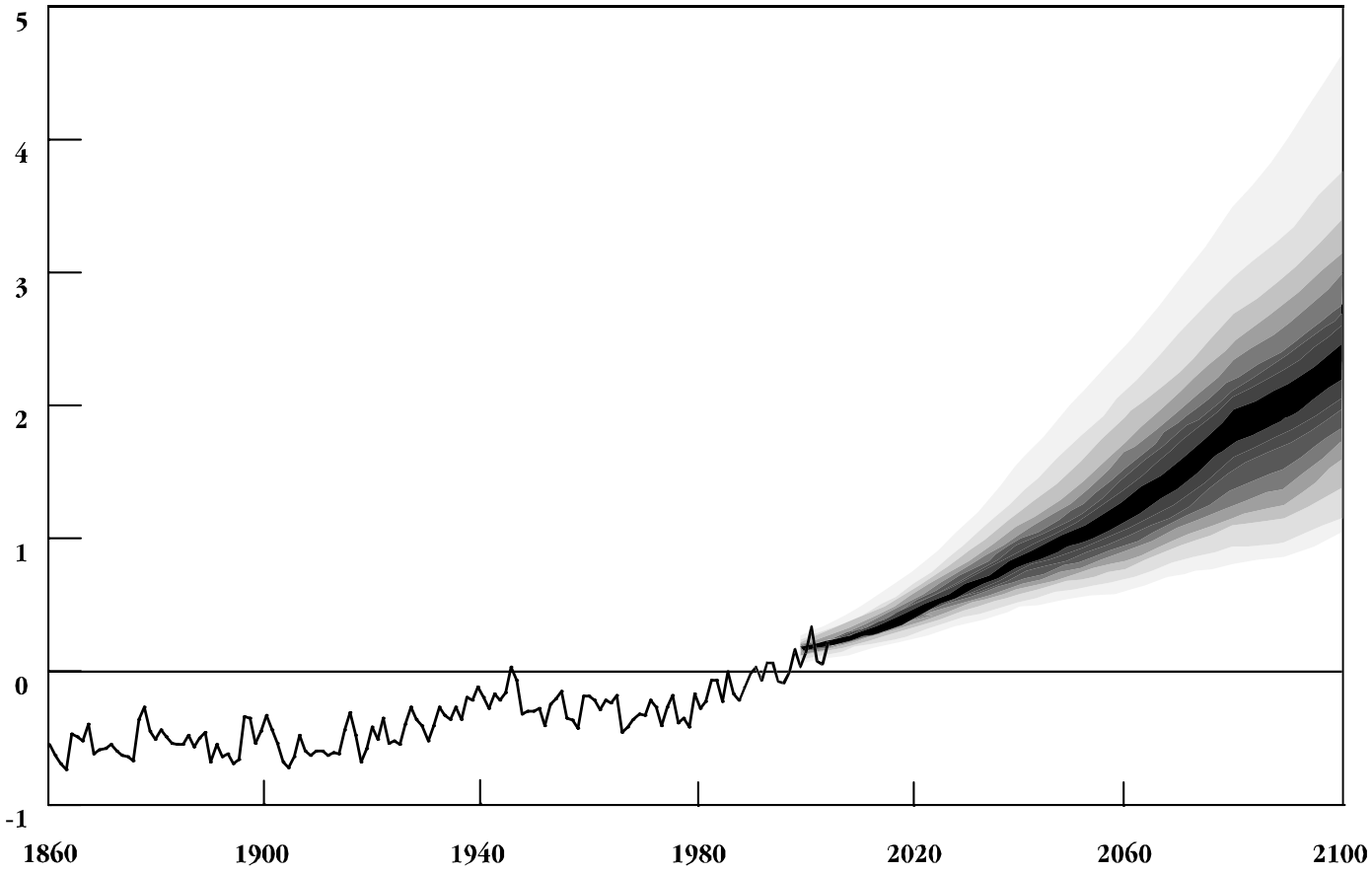
Extensive scientific and economic uncertainty makes predicting and evaluating the effects of such warming extremely difficult. The impacts would vary by region, with some effects positive and others negative. Moreover, some effects could be relatively minor, whereas others could be severe. Warming would raise sea levels. It could also expand the potential range of tropical diseases; disrupt agriculture, forestry, and natural ecosystems; and increase the variability and extremes of regional weather. Actual outcomes will probably be somewhere near the middle of the range of possibilities *(see Figure 1)*. The climate could also shift in abrupt and unexpected ways, which could be much more costly to accommodate than gradual changes would be.

The growth of emissions could be restrained in a variety of ways: by improving the efficiency of energy use, expanding the use of nuclear or renewable power, removing greenhouse gases from smokestacks, and sequestering gases in forests, soils, and oceans. But those alternatives are unlikely to be widely implemented unless measures are taken to lower their costs or to raise the price of greenhouse gas emissions.

Figure 1.

Historical and Projected Climate Change

(Average Global Temperature (°C) Relative to 1986-1995 Average)



Source: Congressional Budget Office. Historical data are from the Hadley Centre for Climate Prediction and Research. The projection is based on research discussed in Mort Webster and others, *Uncertainty Analysis of Climate Change and Policy Response*, Report no. 95 (Cambridge, Mass.: Massachusetts Institute of Technology Joint Program on the Science and Policy of Global Change, December 2002).

Note: The projection, which is interpolated from decadal averages beginning in 1995, shows the possible distribution of changes in average global temperature as a result of human influence, relative to the 1986-1995 average and given current understanding of the climate. Under the Webster study's assumptions, the probability is 10 percent that the actual global temperature will fall in the darkest area and 90 percent that it will fall within the whole shaded area.

Common Resources: Addressing a Market Failure

The Earth's atmosphere is a global, open-access resource that no one owns and that everyone depends on—among other things, as a "sink" for various types of emissions. With growing demands on it, and little incentive for anyone to moderate emissions, the atmosphere is vulnerable to overuse—a problem known as the tragedy of the commons.

The standard remedy for the overexploitation of a common resource is for governments to create and distribute property rights for it, allowing markets to use it efficiently. But the commonality of the atmosphere makes it very difficult to create and enforce individual rights to and responsibilities for its use; consequently, markets alone may not allocate atmospheric resources effectively. It may therefore fall to governments to develop alternative rules or incentives to address the risks from climate change.

Balancing Competing Uses

From an economic point of view, climate policy involves measuring and comparing the values that people place on resources used for alternative purposes at different points in time and applying the results to choose a course of action.

An effective policy balances the costs and benefits of using the atmosphere and distributes both in an acceptable way, with due regard to the uncertainties involved.

Based on current understanding, most assessments of the potential costs and benefits of a warming climate conclude that the continued growth of emissions could benefit some regions but ultimately cause extensive physical and economic damage. Such assessments typically indicate that modest restrictions on current emissions are likely to yield net benefits in the future. However, more-extensive restrictions would crowd out other types of investment, slowing economic growth and reducing current and future generations' material prosperity even more than the averted warming would. The studies conclude that with improved technology and greater income, future generations will be better able to adapt to the effects of a changing climate and to gradually impose restraints on emissions to avoid further alteration.

Those conclusions greatly depend on controversial assumptions about how best to balance the welfare of current generations against that of future generations. The more weight one applies to the welfare of future generations, the more society should reduce its current consumption and increase its overall rate of investment—not only to ensure a beneficial future climate but also to expand the stock of productive physical and human capital of all kinds.

Government policies to address use of the atmosphere will inevitably affect the distribution of resources. Restraints could impose costs on nearly everyone—and would weigh most heavily on energy-producing and energy-intensive industries, regions, and countries. However, inaction would benefit people who are alive today while potentially harming members of future generations.

To complicate matters, climate change might involve large damages in some areas of the world but large benefits in others—even if its net effects were minor. Averting warming might yield significant benefits in at-risk regions at the expense of areas that would stand to gain from a warmer climate. Such distributional issues—between current and future generations, energy-producing and energy-using regions, developed and developing countries, and areas that stand to gain and those that stand to lose—greatly complicate the balancing of interests.

Policy Options

Faced with uncertainty about the magnitude and risks of climate change, governments may respond by adopting a "wait-and-see" approach, allowing further information to accumulate before deciding whether action is warranted. Alternatively, governments may actively pursue research programs—as the United States and other countries have done—to better understand the processes and economic effects of climate change, as well as to discover and develop new and better technological options for reducing or sequestering greenhouse gas emissions. Studies suggest that such research is likely to yield significant benefits by reducing the chances of taking expensive but unnecessary action or by increasing the range and reducing the cost of response options.

Governments may choose from several regulatory approaches, should they decide to constrain emissions. One option is direct controls, which set standards for equipment and processes or regulate the use of specific types of equipment. A less direct and generally more cost-effective alternative—at least for the bulk of greenhouse gas emissions—is to adopt incentive-based approaches that restrict overall quantities of emissions through a system of permits or that raise the price of emissions through fees or taxes.

When costs and benefits are uncertain, as they are in the case of climate change, a system that raises the price of emissions—for example, a tax or a permit system with a set permit price—can have significant advantages over one that establishes an emissions quota. Tightening restrictions on emissions is likely to raise the incremental cost of mitigation much more quickly than it lowers the incremental benefit. As a result, the cost of guessing wrong and imposing an overly restrictive quota could be relatively high. In contrast, the cost of guessing wrong about the appropriate tax level —and perhaps failing to reduce emissions enough in any given year—will probably be relatively low.

A system of emissions pricing has other advantages: it could, for example, raise significant revenues, which might be used to finance cuts in distortionary taxes that discourage work and investment, such as taxes on income. Using the revenues in that way could offset some—though probably not all—of the costs of regulation. Pricing would also be more effective than either quotas or equipment standards in encouraging the development of technologies that reduce emissions.

Emissions pricing or controls could have very large distributional effects, which would depend on the type and stringency of the regulations, on whether the system raised revenues (through taxes or auctioned permits), and on how the government returned the revenues to the economy. With such large stakes, parties affected by regulation might engage in rent-seeking—vying for regulatory provisions that would give them tax exemptions, access to permits, and so on. For example, if the government issued permits free of charge, even permit recipients who were heavily regulated could benefit, while passing the regulatory cost burden on to consumers.

International Coordination

An effective response to the risks posed by climate change will probably require extensive international cooperation because emissions from anywhere mix throughout the atmosphere. But cooperation will be extremely hard to achieve among countries with different circumstances and interests. Developed countries, which up to now have been responsible for the overwhelming bulk of emissions, will very likely be reluctant to take on unilateral commitments while there are less expensive opportunities to constrain emissions in developing countries. But developing nations, which are expected to be the chief source of emissions growth in the future, are reluctant to adopt restrictive policies and thereby limit their potential for economic growth. Such nations have contributed little to the historical rise in atmospheric greenhouse gas concentrations; however, they expect to bear the bulk of the damages that might result from warming.

International coordination could range from modest commitments to engage in research to more-extensive programs to restrict emissions, monitor compliance, and enforce penalties. An international system of restrictions could involve direct controls, taxes, or permits—or it could allow each country to choose an independent approach. No system is likely to gain wide acceptance unless it addresses the crucial sources of disagreement: limiting emissions cost-effectively while distributing the burden of regulation in an acceptable way.

Nearly all the world's nations, including the United States, have signed the United Nations Framework Convention on Climate Change, committing themselves to stabilize atmospheric concentrations of greenhouse gases at levels that would prevent dangerous alteration of the climate. International negotiations under the convention have focused on relatively costly policies that would impose emissions quotas on developed countries while exempting developing nations on distributional grounds. A draft international treaty based on those principles, the Kyoto Protocol, has been the focus of most international negotiations since 1997. Over 100 countries have consented to be bound by it, and it will enter into force if approved by Russia. But quotas—especially those that apply only to some countries—are likely to prove much more costly than policies that uniformly raise the price of emissions everywhere. An approach involving uniform pricing would take advantage of low-cost opportunities to reduce emissions throughout the world and could be supplemented by a separate cost-sharing mechanism. Recognizing that, the United States has declined to participate in the treaty and continues to seek a more cost-effective alternative under the convention.

Related CBO Publications: This brief is based on *The Economics of Climate Change: A Primer* (April 2003), prepared by Robert Shackleton. It and the following related CBO publications are available at the agency's Web site (***www.cbo.gov***): *Reducing Gasoline Consumption: Three Policy Options* (November 2002); *An Evaluation of Cap-and-Trade Programs for Reducing U.S. Carbon Emissions* (June 2001); *Who Gains and Who Pays Under Carbon-Allowance Trading?* (June 2000); and *Climate Change and the Federal Budget* (August 1998). A CBO technical paper, *The Economic Costs of Reducing Emissions of Greenhouse Gases: A Survey of Economic Models*, is forthcoming.