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Projected Economic Impacts of Climate Change

As mandated by Congress, the U.S. Global Change Research Program produces regular National Climate Assessment (NCA) reports on the state of scientific knowledge about climate change and its effects on human and natural systems in the United States. Volume II of NCA4, published in 2018, examines the contributions of individual economic studies, in order to develop consensus conclusions from across the body of climate impacts literature. According to NCA4, "annual losses in some economic sectors are projected to reach hundreds of billions of dollars by the end of the century" provided continued growth in emissions at historic rates. The findings of the NCA4, and those of previous reports, have raised concerns in Congress about the projected economic impacts and questions about the study methods used to derive these projections.

Studies projecting the economic impacts of climate change vary in their scope, methodology, and the intended applications of their findings. Some focus on the effects of one aspect of climate change upon a single type of economic activity (e.g., effects of temperature and carbon dioxide fertilization on corn yields), while others study the effects across a more comprehensive array of market and non-market activities. Recent research, however, provides detailed projections of future impacts of climate change across a variety of sectors of the U.S. economy.

Projections of the economic impacts of climate change have been cited by some Members of Congress to advance climate-related legislation, and have raised questions and concerns about their interpretation and use in policymaking. This product provides an abbreviated overview of climate impacts research, recent projections from the literature, and considerations in interpreting these. In this context, climate impacts are defined as the projected physical and economic effects of climate change, both positive and negative. This product does not discuss the social cost of carbon or similar metrics, which estimate the net present costs associated with emitting additional greenhouse gases (see CRS In Focus IF10625, *Social Costs of Carbon/Greenhouse Gases: Issues for Congress*).

Status of U.S. Climate Impacts Research

While scientific understanding of the physical effects of climate change is supported by a large body of research, the methods for projecting the likely physical and economic effects for specific regions are relatively new and imprecise. Development of these methods remains an area of active research.

Methods of projecting the economic effects of climate change have been in development since the early 1980s. Early attempts to quantify more comprehensive economic effects largely did so on a global scale. Since the early 2000s, advancements in the underlying physical and economic research, data availability, and computing power have allowed the development of more granular approaches, capable of estimating the sum of a wider array of sectoral effects at the national, regional, or even county level. These methods are complex, drawing together insights from a range of disciplines, including climate science, economics, and statistics.

According to a 2017 report of the U.S. Government Accountability Office (GAO), a "small but growing number of researchers" are developing the methods used to project the potential economic effects of climate change within the United States. To date, these methods have been primarily applied to certain economic sectors for which data are readily available and evidence for the relationship between climate and impacts is considered robust. These include human health, labor, energy, agriculture, water resources, infrastructure, and coastal property. Currently, no studies purport to produce a comprehensive estimate of the effects of climate change on the entirety of the U.S. economy.

Recent Projections in the Literature

Two studies, cited in Volume II of the NCA4, provide the most detailed projections to date of the economic effects of climate change across multiple sectors in the United States. These are:

- A 2017 report of the Climate Impacts and Risk Analysis (CIRA) project, coordinated by the U.S. Environmental Protection Agency (EPA) with input from other federal agencies; and
- A 2017 study by Hsiang et al., published in *Science*, and building upon the *American Climate Prospectus*, a 2014 report of the Rhodium Group.

These studies vary in methodology, economic sectors that are included, and choice of metric to report results. Consequently, their findings are not directly comparable.

The 2017 CIRA report provides national and regional economic impact projections for the analyzed sectors in 2050 and 2090 under two emissions trajectories. The report analyzes 22 climate impact sectors within six broad categories: health, infrastructure, electricity, water resources, agriculture, and ecosystems. Results are presented in real 2015 dollars for each sector, but are not aggregated into a single economy-wide estimate. Under a high emissions scenario with limited adaptation, net losses in labor, extreme temperature mortality, and coastal property are estimated in the hundreds of billions of dollars

per year by the end of the century. Of the 22 sectors analyzed, one is estimated to result in net benefits in 2090.

The Hsiang et al. study projects net climate impacts in six sectors—agriculture, crime, coastal property, energy, human mortality, and labor—under three emissions trajectories for 2080 through 2099. They report their findings as a percentage of gross domestic product (GDP). Annual net economic costs across the sectors are estimated to cost "roughly 1.2% of [GDP] per +1°C on average," with estimates ranging from +0.1% (net benefit) to -1.7% (net cost) GDP at low levels of warming (1.5°C) through -6.4% to -15.7% of GDP under a higher warming scenario (8°C).

Selected Considerations in Interpreting Climate Impact Projections

Climate impact researchers and other experts caution that estimates should *not* be interpreted as predictions of actual future impacts. Instead, researchers suggest the estimates may provide insights into the potential direction and magnitude of impacts, depending on varying assumptions. Some critics suggest that the inherent uncertainties associated with projecting to the end of the century make the net costs of climate change in that timeframe fundamentally unknowable. Beyond these central concerns, additional considerations, discussed below, may be of interest to policymakers.

Analytical Challenges

The NCA4 notes that the research literature on physical and economic impacts in the United States remains incomplete in its coverage of the range and magnitudes of potential impacts. Challenges to quantification include, among others:

- The wide variety of economic sectors likely affected by climate change, the complexity of the effects, and the existence of complex feedbacks among sectors;
- Lack of metrics for monetizing some of the non-market effects (e.g., loss of biodiversity, ecosystem damages);
- The long timescales over which some greenhouse gases persist in the atmosphere;
- The difficulty of long-term projecting;
- Uncertainty surrounding possible climatic or societal tipping points, beyond which impacts may accelerate or become irreversible; and
- Uncertainty surrounding the magnitude and efficacy of future adaptation, which may reduce the economic effects of physical impacts (and incur its own costs).

Some observers suggest that these challenges have resulted in estimates that systematically underestimate the actual future costs associated with climate change. Both the Hsiang et al. and the CIRA study acknowledge their incomplete coverage and plan to expand it as the underlying research develops. By contrast, some argue that insufficient accounting for adaptation may overestimate the economic impacts on humans and ecosystems.

Treatment of Social Values

Economic models are sensitive to assumptions that often contain judgments about the relative value society places on various outcomes. Examples of social values that may be included in climate models are time preference/discounting (i.e., the extent to which society values costs occurring in the present more than those occurring in the future), risk tolerance, and consideration of outcomes that affect social inequality. Hsiang et al. project that the valuation of the economic damages increases by a factor of between 1.3 and 4.6 if social aversion to inequality is included in the analysis. There is no consensus about the appropriate treatment of social preferences in economic impact estimates. Whether and how these values are accounted for influences both the final estimate and its interpretation for policymakers.

Distribution of Economic Impacts

Projections of aggregate national effects may obscure variations by region and socioeconomic distribution. Climate effects vary by geographical region depending on factors such as the current climate and climate-sensitivity of the locality. For instance, CIRA projects relatively moderate climate impacts in some sectors in the Northwest as compared to other U.S. regions. These variations may transfer value over time from some regions of the country to others. Hsiang et al. project that climate change is likely to generate a transfer of value from the southern and eastern portions of the United States to the northern and western regions. The same study estimates that the impacts could disproportionately affect low-income communities, tending to increase existing inequalities.

Choice of Reporting Metric

The choice of metrics used to report potential economic impacts can influence the interpretation of the results. For example, GDP, as calculated by the U.S. government, measures the value of goods and services produced in the United States, but does not necessarily distinguish between costs and benefits. As a result, some effects of climate change, which could be considered adverse impacts (e.g., property loss to hurricanes), may yield an increase in GDP because they increase economic activity for relief and recovery, while the loss of assets may not be fully counted.

Some researchers (including Hsiang et al.) calculate net costs under their own methodology rather than that traditionally used to calculate GDP, but still report their findings as a percentage of GDP in order to place the estimated costs in the broader context of total economic productivity. The interpretation of these estimates is distinct from those that directly calculate the impacts on future GDP levels or growth due to the differential treatment of costs and benefits when calculating the final estimates.

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