Economic Perspectives on Climate Change

William D. Nordhaus
Yale University

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Outline of presentation

Part I
- An overview of issues of climate change
- Impacts of climate change

Part II
- Economic aspects of global warming
- Alternative approaches to policy
The challenge of climate change

- This is a relatively new issue:
  - global, costly, large impacts
- Affects virtually every area of society and the economy
  - Food, migration, health, energy, national defense, transportation, coastlines, …
- It will require every area to adapt and be innovative
- I will emphasize an economic innovation: using the market mechanism to achieve environmental goals.

Climate change requires very long-term thinking
Emissions and climate science
Global CO$_2$ emissions since 1900

Trend in CO$_2$ emissions relative to GDP, US
Determinants of long-run emissions growth

Kaya identity: \( \text{CO}_2 = \text{Pop} \times (\text{GDP/Pop}) \times (\text{CO}_2/\text{GDP}) \)

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2050</th>
<th>Growth rate (% per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP/Pop (2005 $/person)</td>
<td>41,725</td>
<td>83,689</td>
<td>1.6%</td>
</tr>
<tr>
<td>CO2/GDP (tons/1,000,000 $)</td>
<td>134</td>
<td>62</td>
<td>-1.7%</td>
</tr>
<tr>
<td>Population (millions)</td>
<td>297</td>
<td>399</td>
<td>0.7%</td>
</tr>
<tr>
<td>Total CO2 Emissions (million tons C)</td>
<td>1,661</td>
<td>2,059</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

CO\textsubscript{2} concentrations at Mauna Loa
The Greenhouse Effect:

Fossil (C) fuel + O₂ → Energy + CO₂

CO₂ has long atmospheric residence time as gas.

CO₂ is a “greenhouse” gas that retains surface heat.

A CO₂ Blanket

Instrumental record: global mean temperature index (°C)

<table>
<thead>
<tr>
<th>Year</th>
<th>GISS</th>
<th>Hadley</th>
<th>US NCDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1850</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1875</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1900</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1925</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1950</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>1975</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>2000</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Temperature anomaly (1895-1905 = 0)
Projections and the paleoclimatic record

Temperature record and projections to 2200, Vostok core, Antarctica

The Impacts of Climate Change
The Impacts of Climate Change

The Copenhagen Accord, which recognized “the scientific view that the increase in global temperature should be below 2 degrees Celsius.”

Is this firmly based in “scientific” estimates of the impacts of climate change?

Facts on the ground:
- Estimating impacts has been the most difficult part of all climate science: house-to-house combat for analysts.
- Very scant empirical support for the 2 degree target

Economic effects in the climate change arena

1. Effects of climate change policies (carbon taxes, cap and trade, regulations, …)

2. Effects of adaptation (moving roads and houses, changing crops, investing in new technologies, …)

3. Effect of climate change (floods, sea-level rise, crop losses, …)
### What will be the economic effects by sector?

<table>
<thead>
<tr>
<th>Industry</th>
<th>Impact of Climate policies</th>
<th>Impact of Adaptation policies</th>
<th>Impact of Climate-change impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy-intensive</td>
<td>Large near term</td>
<td>Moderate medium term</td>
<td>Moderate long term</td>
</tr>
<tr>
<td>&quot;Nature-intensive&quot;</td>
<td>Small</td>
<td>Moderate medium term</td>
<td>Large long term</td>
</tr>
<tr>
<td>Other</td>
<td>Small</td>
<td>Small</td>
<td>Small</td>
</tr>
</tbody>
</table>

But the actual science and economics are complex: The example of low-latitude wheat
We need to put climate change in the future, not in today’s world

End of PART I

Discussion:

How will climate change affect your field?
How will it require changes in both thinking and action in your field?
Have you seen climate change affecting your field already?
PART II.
Economics of Global Warming

Climate change requires very long-distance thinking as well as long-time-horizon thinking
The basic dilemma about global warming

Damages from climate change are:
- dispersed among many countries
- very far in the future
- highly uncertain and controversial
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Damages from climate change are:
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- very far in the future
- highly uncertain and controversial

Costs of slowing climate change are:
- relatively high
- hit the current generation
- hit particular sectors (energy) and countries (energy producers and energy-intensive consumers)

Economic Models of Global Warming

Yale has pioneered building models of global warming economics.

Major findings:
- Need a “carbon price” to slow warming efficiently
- The major impact will be on energy prices
- If implemented in a “smart” way, it will have relatively low economic costs.
Two Inconvenient Economic Truths

1. To be effective, firms and consumers must face a market price of carbon emissions that reflects the social costs.
2. Moreover, to be efficient, the price must be universal and harmonized in every sector and country.

How should we implement policies?

- Internationally harmonized carbon tax
- Universal cap and trade

- Regulatory substitutes (CAFE standards, ban on light bulbs, …) – very inefficient approaches
- Voluntary measures (carbon offsets) are difficult to calculate and verify and probably a useless diversion.
The Current International Approach

Began with Framework Convention on Climate Change (1992), a voluntary agreement to “prevent dangerous” climate change.
First steps were Kyoto Protocol
Kyoto Protocol negotiated in 1997
- Limiting emissions to fraction of 1990 rates
- Limited to high-income countries
- Only agreed for 2008-2012 period

Developing countries have no emissions targets.
Allows trading of emissions permits among countries
Protocol went into effect in Feb 2005 after Russian ratification.
Kyoto Protocol has suffered from extreme attrition …

Fraction of Global Emissions Covered by KP

The Copenhagen Meeting

Successor to Kyoto Protocol took place in December 2009 in Copenhagen.

There was no binding agreement on emissions.

Unresolved problems:
- What are targets of rich countries?
- Will the US participate?
- Will middle income countries take on commitments?
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- What are targets of rich countries?
- Will the US participate?
- Will middle income countries take on commitments?
- What mechanism will be in place to encourage reductions in poor countries?
- Who will pay for efforts in poor countries, and through what mechanism?

There was an agreement on a goal (2 °C for limits)
Countries agreed to aspirational targets.

US Policy on Climate Change

• US played central role in Kyoto negotiations in 1997.
• However, Clinton administration did not submit for ratification.
• Obama administration has endorsed joining and supports bills.
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- However, Clinton administration did not submit for ratification.
- Obama administration has endorsed joining and supports bills.
- House passed a bill, but it died in the Senate… and in 2010 elections.
- All US bills have firmed endorsed cap and trade, with heavy regulatory burdens and trade sanctions.
- Major opposition in Congress from:
  - Republicans
  - Energy state Democrats

Rate of growth of CO2-GDP ratio: history and current proposal
A different approach: carbon taxes

- Economists have been skeptical about the Kyoto approach
- Some have suggested an alternative that fits better into current governmental structures: a carbon tax

**Basic concept of carbon tax**

1. Tax goods proportional to their CO₂ content.
2. Tax should be harmonized across all industries and countries.
3. Suggested level to reach Copenhagen target: $25 per ton of CO₂ rising over time.
4. Can reduce other taxes or use revenues for public goods.
5. Can provide fiscal and technological support for poor countries.
Impact of $25 carbon tax on energy prices, US

<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
<th>Without carbon price</th>
<th>With carbon price</th>
<th>Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prices (2005 $)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline</td>
<td>$ per gallon</td>
<td>3.04</td>
<td>3.30</td>
<td>8.7</td>
</tr>
<tr>
<td>Electricity</td>
<td>cents per kwh</td>
<td>10.37</td>
<td>12.16</td>
<td>17.2</td>
</tr>
<tr>
<td>Coal</td>
<td>$ per short ton</td>
<td>28.78</td>
<td>97.51</td>
<td>238.9</td>
</tr>
<tr>
<td>Expenditures (2005 $ per person)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasoline</td>
<td>$ per person</td>
<td>1,222</td>
<td>1,329</td>
<td>8.7</td>
</tr>
<tr>
<td>Energy</td>
<td>$ per person</td>
<td>1,886</td>
<td>2,082</td>
<td>10.4</td>
</tr>
</tbody>
</table>

Why carbon taxes are preferable to cap-and-trade

1. Quantity-type regimes show extremely volatile prices.
2. Cap and trade loses revenues because of allocation.
3. Because of #2, cap and trade is subject to severe rent seeking.
4. Because of allocations, subject to corruption.
Outlook for the future

1. Global warming will be a major issue for the indefinite future.
2. Best approach is a universal carbon tax.
3. Countries should plan for the worst (rapid warming and serious impacts) …
   while continuing to work for an effective agreement.
End of PART II

Discussion:

Will the economic impacts be large or small in your area?
Will there be large adaptations necessary in your field?
Will the new approaches (such as environmental taxation or regulation) require transformative thinking in your field?