Climate impacts on labor productivity and long-term economic growth

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Outline

1. Empirical methodology
2. Main findings
3. Implications for economic growth
4. Implications for the social cost of carbon
1. Empirics: Methodology

Objective: Finding dose-response functions for climate impacts

Figure from Carleton et al. (2016)
1. Empirics: Climate and wealth

Montesquieu (1748): “There are countries where the excess of heat ... renders men so slothful and dispirited ...”

• Cross-country studies: Warmer countries are poorer (Nordhaus 2006)

• Is this causal? → Establishing causality hard due to unobserved heterogeneity
1. Empirics: Causality

- Identification of characteristic social responses (micro level)
- Panel methods allow for causal identification
- Societies may or may not recover and adapt over time
- Response to weather not sufficient to know climate impacts
  → Adaptation

Figure from Carleton et al. (2016)
2. Main findings

Non-linear climate impacts found across sectors
2. Main findings: Aggregate estimates

Aggregate estimates much larger than bottom-up studies suggest:

What explains the difference?

Hypothesis:
Direct impacts on human physiology & economic growth

Figure from Burke et al. (2015)
2. Main findings: Direct impacts

Direct impacts on human physiology:

a) Discomfort, morbidity, mortality

Figure from Carleton et al. (2016)
2. Main findings: Direct impacts

b) Cognitive ability, task performance

- Adaptation far from perfect:
  - Call centers (India)
  - Vehicle production (USA)

→ Impacts labor supply and productivity

Figure: Seppanen et al. (2006)
3. Growth effects: Human capital formation

Impacts on education and health

→ Human capital formation affected?

H

Math test scores (USA)
Graff Zivin et al. (2015)

B

Female infant mortality (Philippines)
Anttila-Hughes & Hsiang (2012)

Figures from Carleton et al. (2016)
3. Growth effects: Long term

If human capital formation (labor productivity growth) affected

→ high long-term economic damages
3. Growth effects: Adaptation

Long-term economic growth and welfare effects crucially depend on adaptation:

- Societal change (preferences)
- Migration
- Structural change, potential for maladaptation (Kalkuhl et al., 2016)
- Trade
- Technical adaptation measures and their limits

→ Successful adaptation requires right incentives, rational planning, financing, strong institutions and risk sharing.
→ Long term growth effects are a research challenge
4. Social cost of carbon

Social cost of carbon (SCC) = damages due to an additional emission in monetary terms

- Relevant in regulatory contexts (United States especially)
- Determined by
  - Climate impact estimates (descriptive)
  - Societal preferences, e.g. for equity across nations, generations, and income classes (normative)

\[
SCC_B = \sum_{i=1}^{T} \sum_{r=1}^{R} \Delta C_{ir} \frac{\partial W}{\partial C_{ir}} \frac{\partial W}{\partial C_{1B}}
\]
4. Social cost of carbon: Impact estimates

Growth damages increase optimal near-term mitigation

→ Need for modeling based on micro findings

Figure from Schultes et al., forthcoming
4. Social cost of carbon: Inequalities

Three sources of inequality matter:

- Existing national and international income inequalities
- Climate impacts often regressive, as
  - poor countries warmer
  - adaptation harder when poor
  - the poor work in more exposed sectors
  - poor areas exposed to higher pollution
- Climate policy itself can be regressive or progressive

⇒ If inequalities are not addressed by redistribution, they strongly influence optimal climate policy
4. Social cost of carbon: Influence of inequality

Dennig et al. (2015):

Models often operate on coarse scale with global/regional representative agent

- subnational inequality in income and damages: no transfers
- Equal regional consumption: unlimited, first-best transfers
4. Social cost of carbon: National institutions

1. **Global governance level**: determines optimal climate policy with national optimal carbon taxes without international transfers

2. **National governance level**: determination of distribution between households $j$ in country

\[
\max \sum_{t=0}^{T} \frac{1}{(1 + \rho)^t} \left( \sum_{i=1}^{N} \sum_{j=1}^{h_i^t} w_{ij}^t u_{ij}^t \right) \\
\text{s.t. } \sum_{j=1}^{h_k} L_{kj}^t = 0 \\
F_{kl}^t(\cdot) = 0
\]

Based on Kornek et al. (2017)
4. Social cost of carbon: Numerical example

Not addressing in-country inequalities strongly increases the SCC.

SKC in USD/GtC

USA, nationally optimal transfers
India, nationally optimal transfers
USA, no national compensation
India, no national compensation

Based on Kornek et al. (2017)
4. Social cost of carbon: Inequalities

National:

• Implementation of climate policy into fiscal and tax policy decisive for efficiency and distributional impacts (Siegmeier et al. 2015)
• Revenue from climate policy can eliminate regressive effects of climate policy (Klenert et al., 2016)

International:

• International transfers influence optimal climate policy (Kornek et al., 2017)
Conclusions

- Advances in causal inference allow identifying climate impacts
- Direct impacts on human physiology
- Economic growth may be impacted, adaptation is key
  - Need for better long-term modeling
- Social cost of carbon as central measure of impacts
- Inequalities and social preferences strongly influence SCC and optimal climate policies
  - Science should not only provide numbers, but also embrace multiple perspectives on justice and fairness.
Literature


