The Climate Adaptation Feedback

Alexander C. Abajian (UCSB)
Tamma Carleton (UCSB)
Kyle C. Meng (UCSB)
Olivier Deschênes (UCSB)

NBER Summer Institute – Environmental & Energy Economics Workshop

July 25th 2023

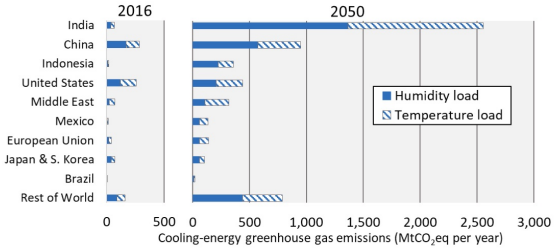
Climate change and adaptation through energy use

Research Question

Will adaptation to climate change increase future emissions and lead to additional warming?

Energy use can mitigate harm:

- Nearly all the 75% decline in historical US heat-related mortality explained by air conditioning adoption (Barreca et al., 2016)
- Adaptation through energy use could reduce mortality due to climate change in 2100 by 60% (Carleton et al., 2022)
- Adaptation may be energy (and with it emissions) intensive



NREL (2022)

The Climate Adaptation Feedback

Definition: Climate Adaptation Feedback (CAF)

The difference in global mean surface temperature (GMST) with and without adaptation.

A non-zero CAF:

1. Implies bias in existing estimates of the social cost of carbon that do not account for adaptation
2. Validates concerns that encouraging air conditioning and other energy-based adaptation may exacerbate existing inequities
3. Alters business-as-usual emissions

Constructing the CAF – I

Under a given SSP-RCP pair for location i in year t:

Step 1: Calculate future temperature distributions

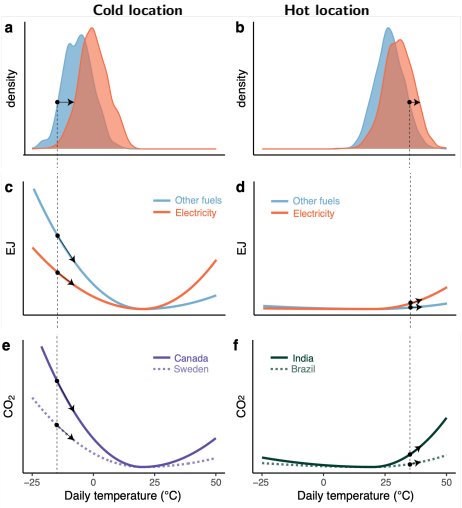
$$\mathrm{T}_{i,0} \rightarrow \mathrm{T}_{i,t}$$

Step 2: Forecast how demand would change under a warmer climate relative to the present-day (Rode et al., 2021)

$$\Delta J^h_{i,t} = J^h(\boldsymbol{T}^N_{i,t}, \boldsymbol{X}_{i,t}) - J^h(\boldsymbol{T}^N_{i,0}, \boldsymbol{X}_{i,t})$$

Step 3: Calculate associated changes in CO_2 emissions

$$E_{i,t} = \textstyle\sum_h F^h_i \Delta J^h_{i,t}$$



Constructing the CAF – II

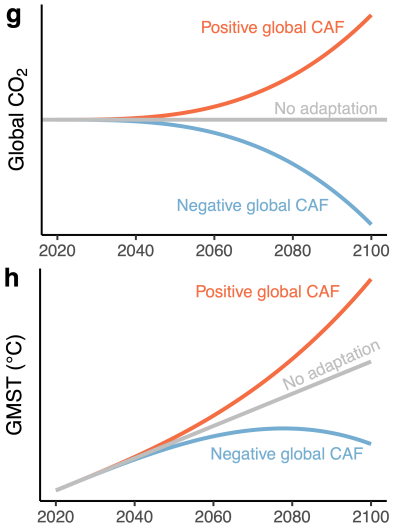
Step 4: Aggregate at the global level

$$\mathcal{E}_\tau = \sum_{t=0}^{\tau} \sum_i E_{i,t}$$

Step 5: Solve for the resulting temperature change

$$\begin{aligned} CAF_\tau &\stackrel{def}{=} \Delta \overline{T}^A_\tau - \Delta \overline{T}^N_\tau \\ &= \beta \mathcal{E}_\tau \end{aligned}$$

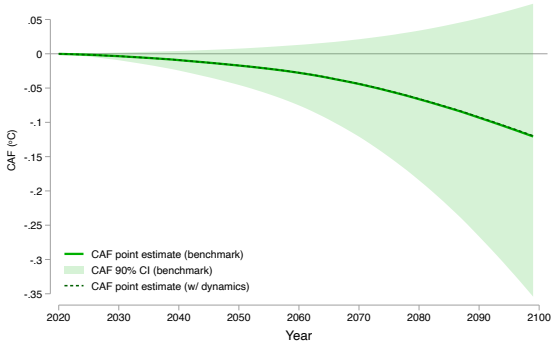
where β maps cumulative CO_2 emissions to GMST.



Adaptation will lower emissions relative to baseline

The CAF is negative:

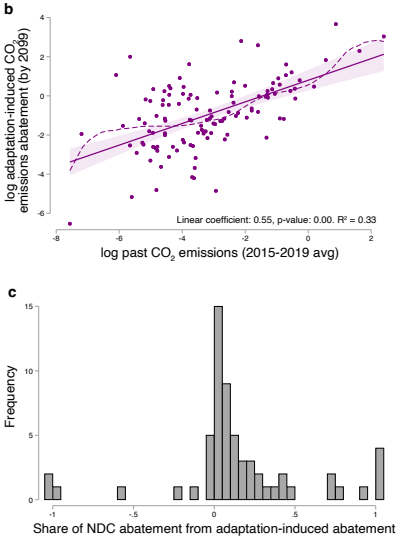
- Energy-based adaptation lowers GMST by **0.12**°C [-0.35, 0.073] by 2099
- Magnitude contextualized:
  - ∼6 yrs of recent warming
  - Reduces present value of damages from climate change over 2020-2099 horizon by $1.8 Trillion



Adaptation induces policy-relevant emissions reductions

National-level energy-based adaptation:

- Lowers future CO_2 emissions for 85% of countries
- More implied abatement for larger emitters
- Reduces required abatement to meet 2050 NDCs (Meinshausen et al., 2022) by 11% on average



Conclusion

We find evidence that the CAF – the feedback between adaptive energy consumption and climate change – is negative:

- Assuages concerns that adaptation (e.g., increased AC use) in higher income countries will substantially accelerate climate change
- May imply bias in current estimates of the SCC from models that omit behavioral feedback channels
- Helps better inform future emissions reduction targets