The Economic Geography of Global Warming

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(based on work with José Luis Cruz)

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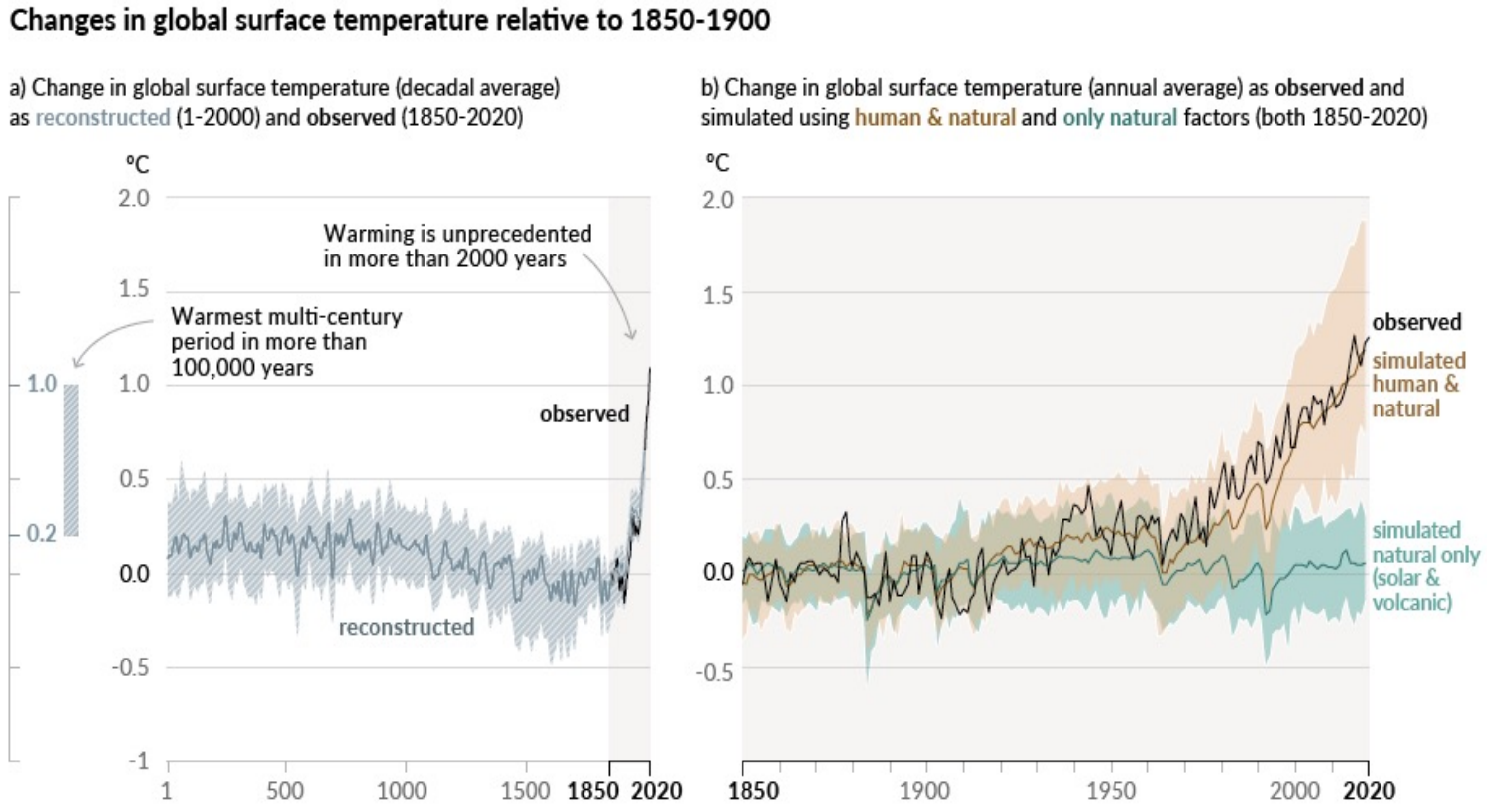
IATRC
INTERNATIONAL AGRICULTURAL TRADE RESEARCH CONSORTIUM

Carbon Emissions and Climate Change

CO_2 concentration in the atmosphere has grown rapidly since 1850

Anthropogenic effect on climate due to industrialization, transportation, and other economic activity

Has led to an increase in average temperatures



Global Externality: Individual emissions affect global climate for everyone, not just for emitter

What is the Economic Cost of Climate Change?

Cost must be associated with the cost of changing the location of economic activity:

Spatial frictions (trade costs, migration costs, cost of changing specialization)

Costs and benefits from density

Why?

- Range of temperatures in the world (0 - 28 °C) is large relative to extreme predictions of temperature increases (6 to 8 °C over 200 years)
  - Heterogeneous spatial effects: some places become too hot to live or produce, whereas others will benefit
  - If patterns of specialization can change and people can trade and move, overall effect is likely to be small

- Most land is economically unused and empty (G-Econ 4.0)
  - 90% of production happens in 10% of area
  - 72% of people live on 10% of land

- Making some land unfit for production implies a small cost for the world economy
  - Of course, cost can be large for specific locations and people

Adapting by Moving: Examples

- The Medieval Warm Period (9th to 13th centuries)

  > “brought bounty to some areas, but to others, prolonged droughts that shook established societies to their foundation" (Fagan, 2009)

  - Population growth in (Northern) Europe
  - Decline of Meso-American cultures and the Khmer empire

- Trade patterns change in the face of climate change:
  - During the 12th and 13th century (before Ricardo!) England used to export wine to France
  - Long-distance trade in the Arctic

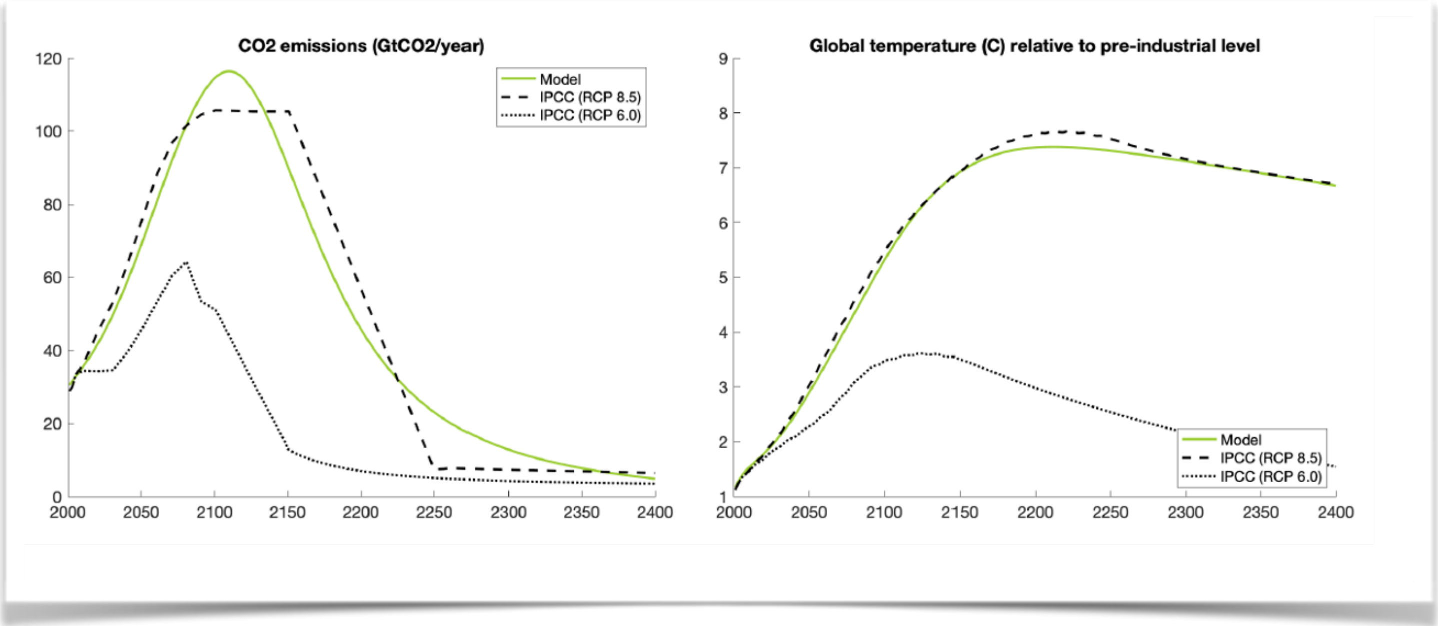
- Large-scale movement of people to adapt:
  - Norsemen settled Iceland, Greenland, and parts of Newfoundland
  - The expansion of the Mongol Empire under Genghis Khan
  - The Dust Bowl in the 1930s displaced 2.5 million Americans from the Great Plains

Evaluating the Economic Cost of Global Warming

Need to incorporate in the analysis many locations and ability to shift location of economic activity

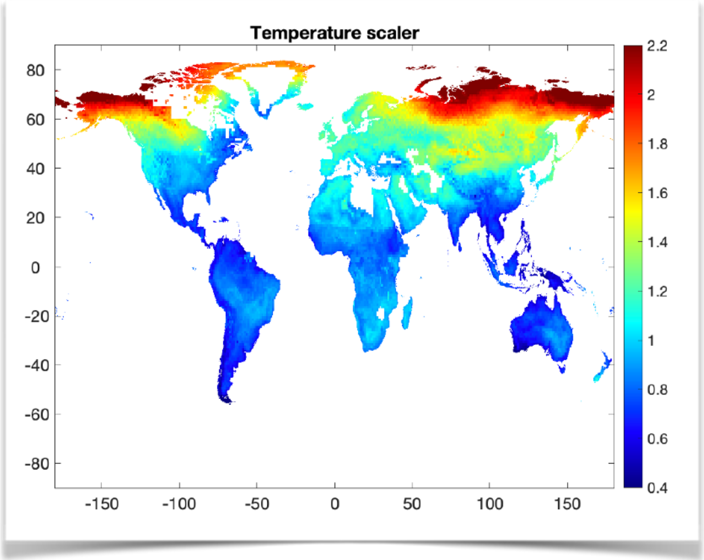
Emphasize role of innovation, fertility, mobility, and trade

Need behavioral model of agents' actions since it is hard to extrapolate empirically (new reality and long periods)



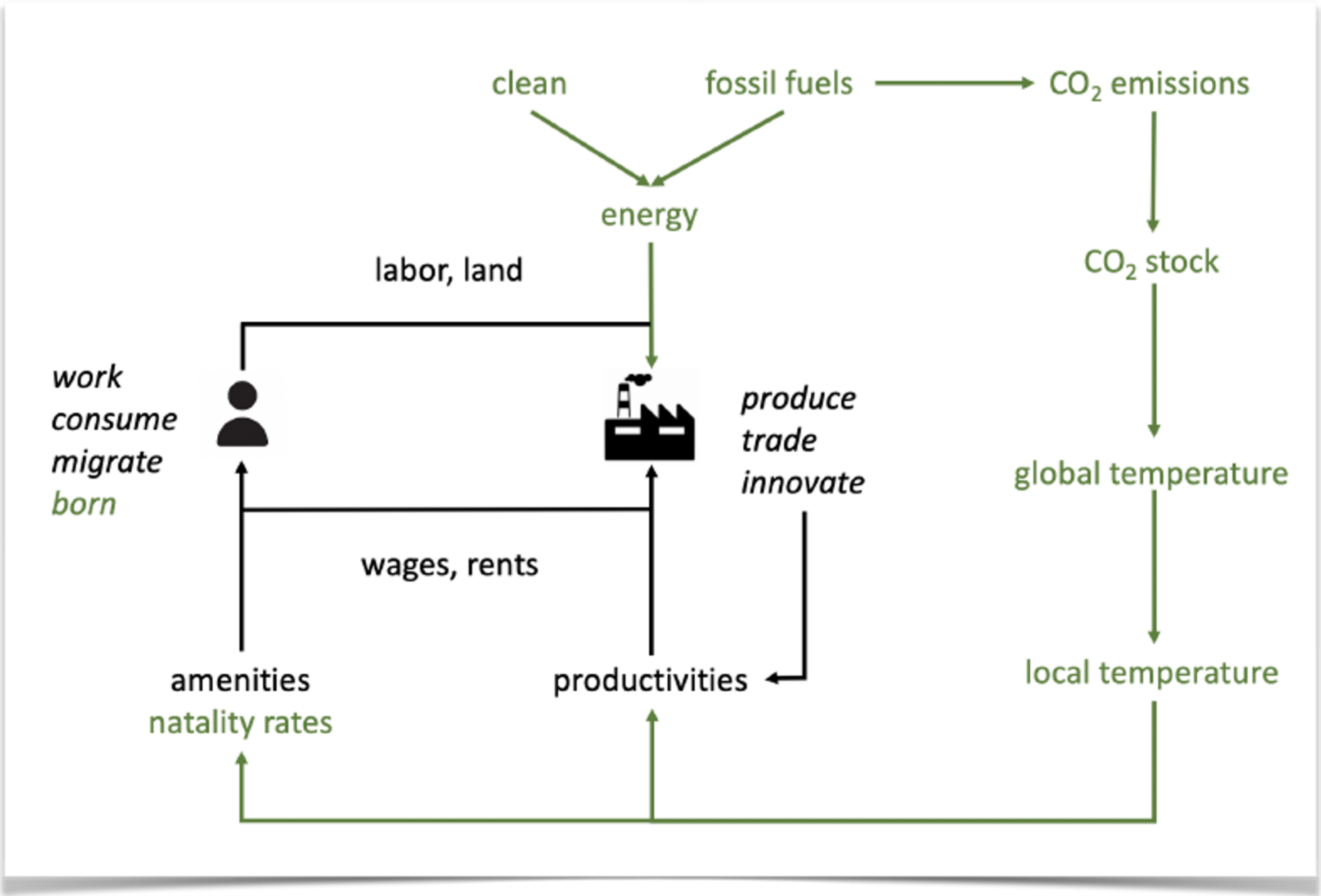
Climate change scenario depends on agents' actions plus assumptions on total stock of carbon and energy share in production (6%)

Model leads to scenarios close to RCP 8.5. Combine with local temperature scaler to get local temperature effects



Basic Model Structure

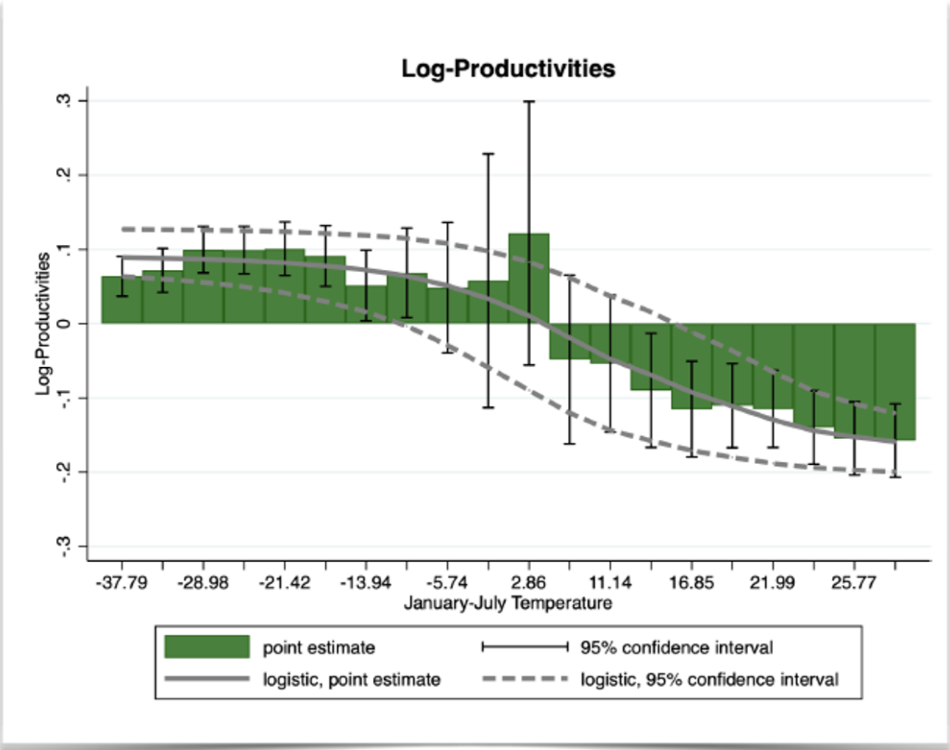
The model in a nutshell:



Use data on income and population in 2000 to obtain productivity and amenities

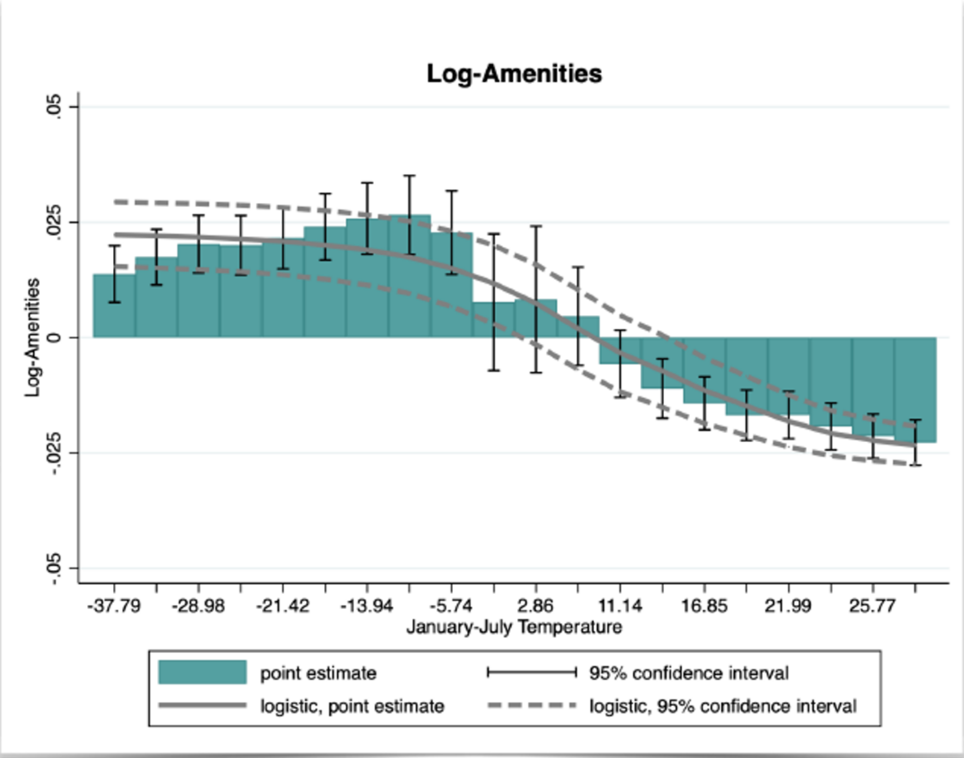
Set trade and mobility frictions to match empirical trade flows (gravity) and net migration flows

Damage Functions for Productivities and Amenities



Shows the semi-elasticity of productivity and amenities to increases in temperature: % change from an additional °C

Effect varies by current temperature

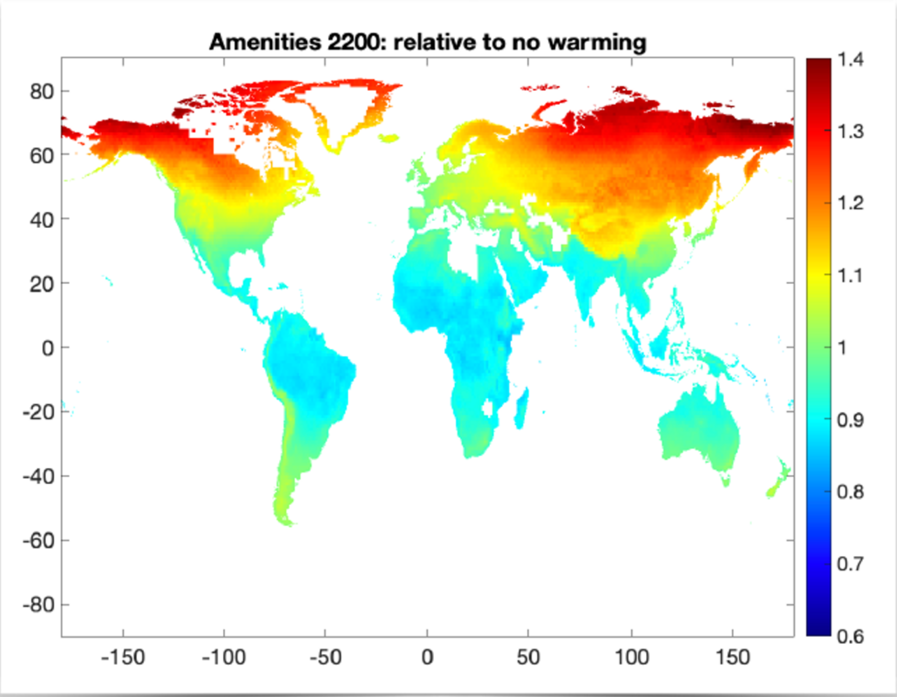


After controlling for other sources of changes (innovation), local natural attributes, plus year-region fixed effects

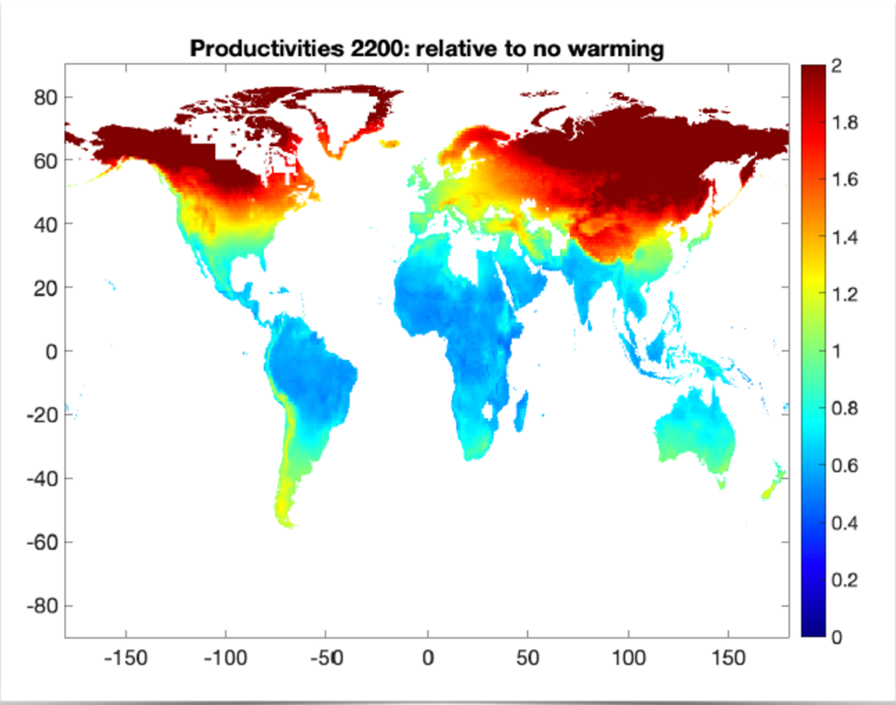
Estimates are noisy since local changes in temperature up-to-date are not so large

Local Effects of Global Warming on Amenities and Productivities

Use estimated damage functions to estimate effect of climate on amenities and productivity



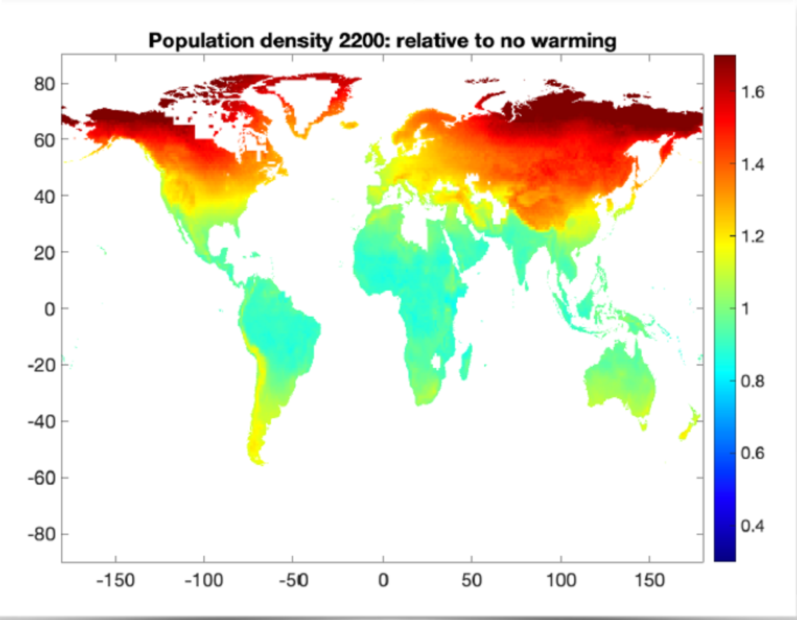
Effects vary mostly by latitude

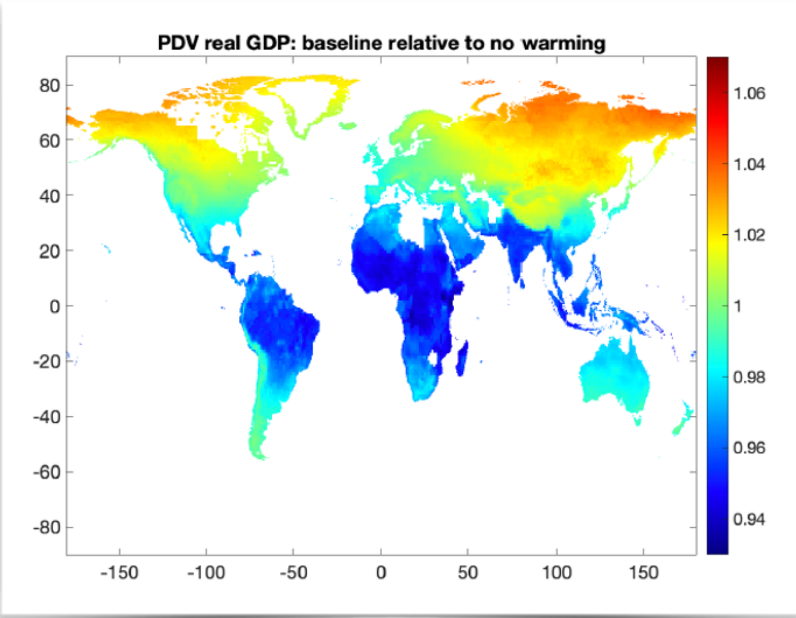


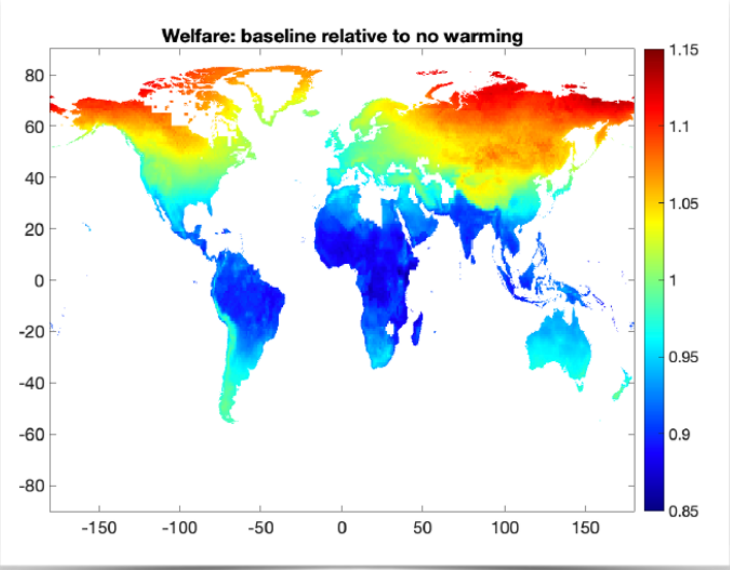
In 200 years, climate will:
Change amenities between +40% to -30%
Change productivity from +80% to -50%

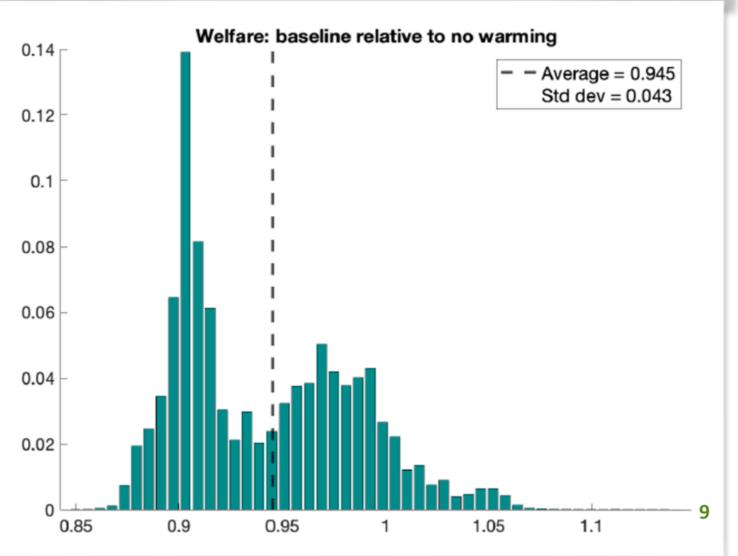
Estimates of the Local Economic Cost of Global Warming

Calculate the dynamic effect on location, real GDP, welfare



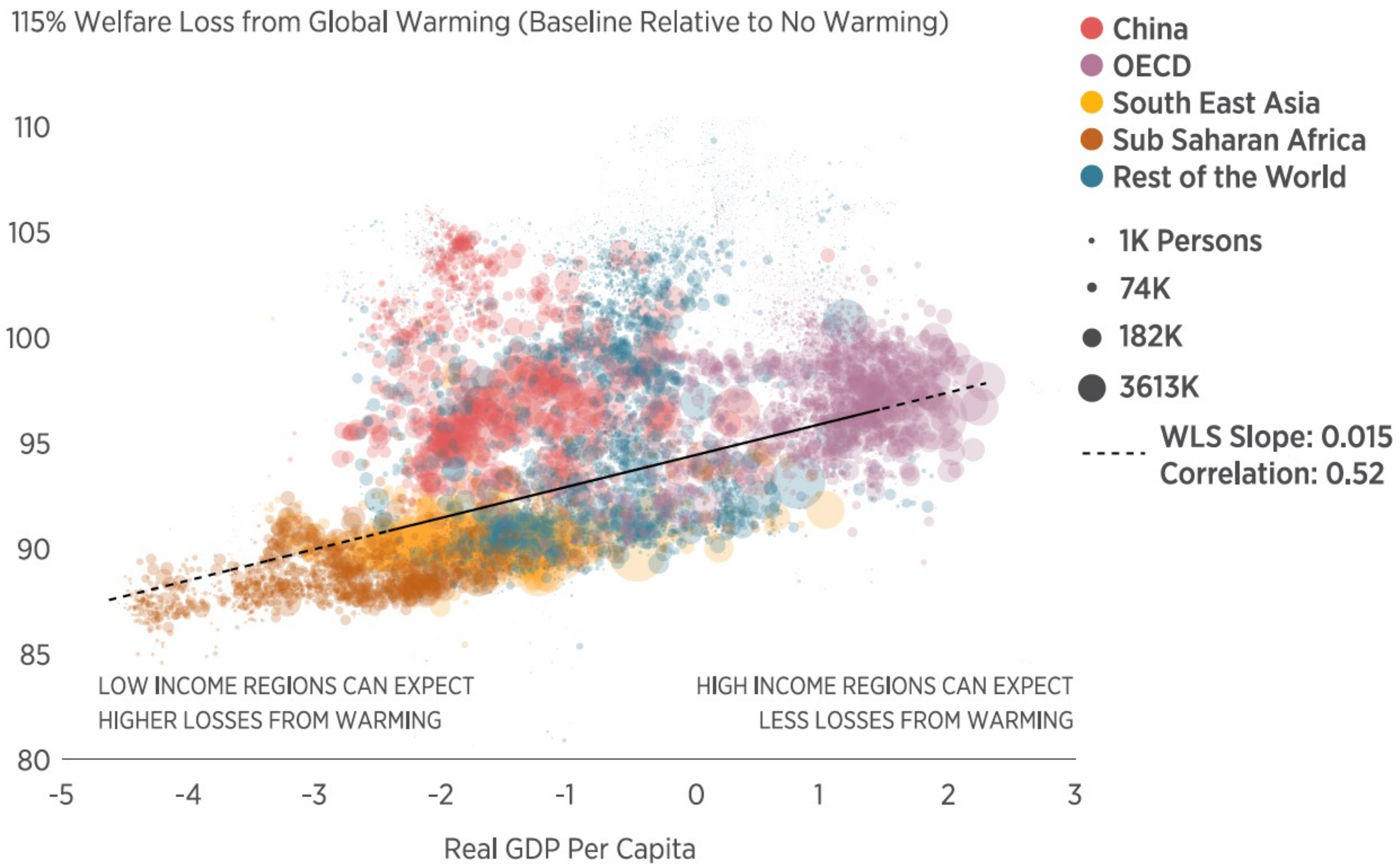




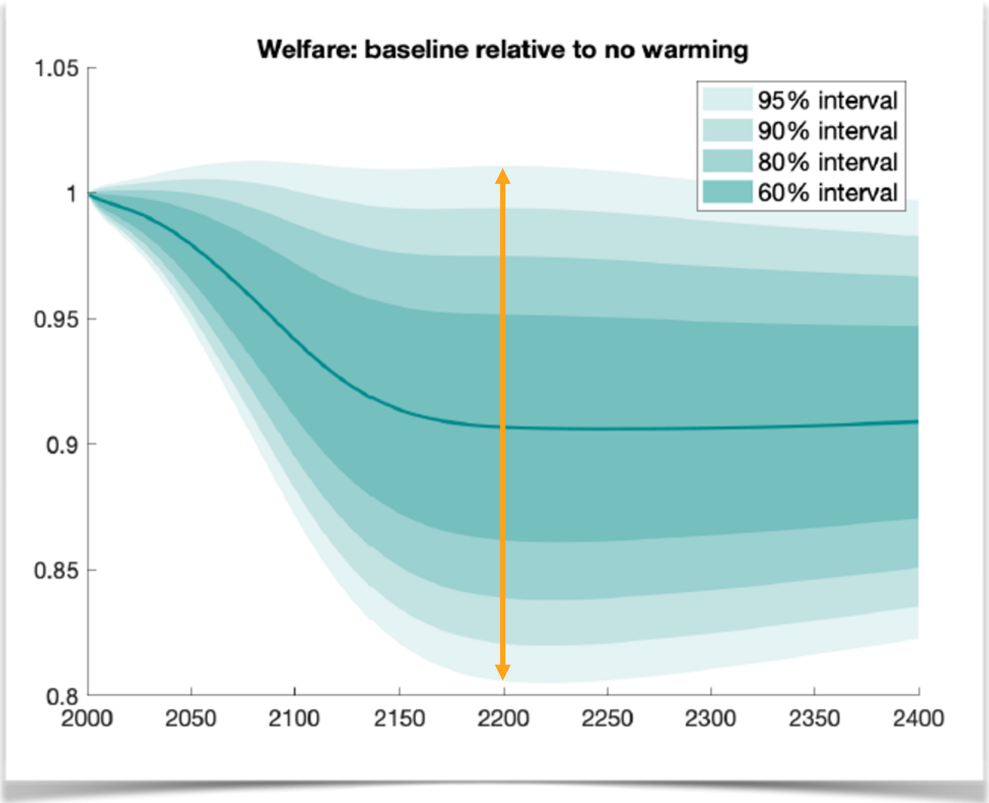


Effect on welfare larger than effect on GDP due to deterioration of amenities

Global Warming and Inequality

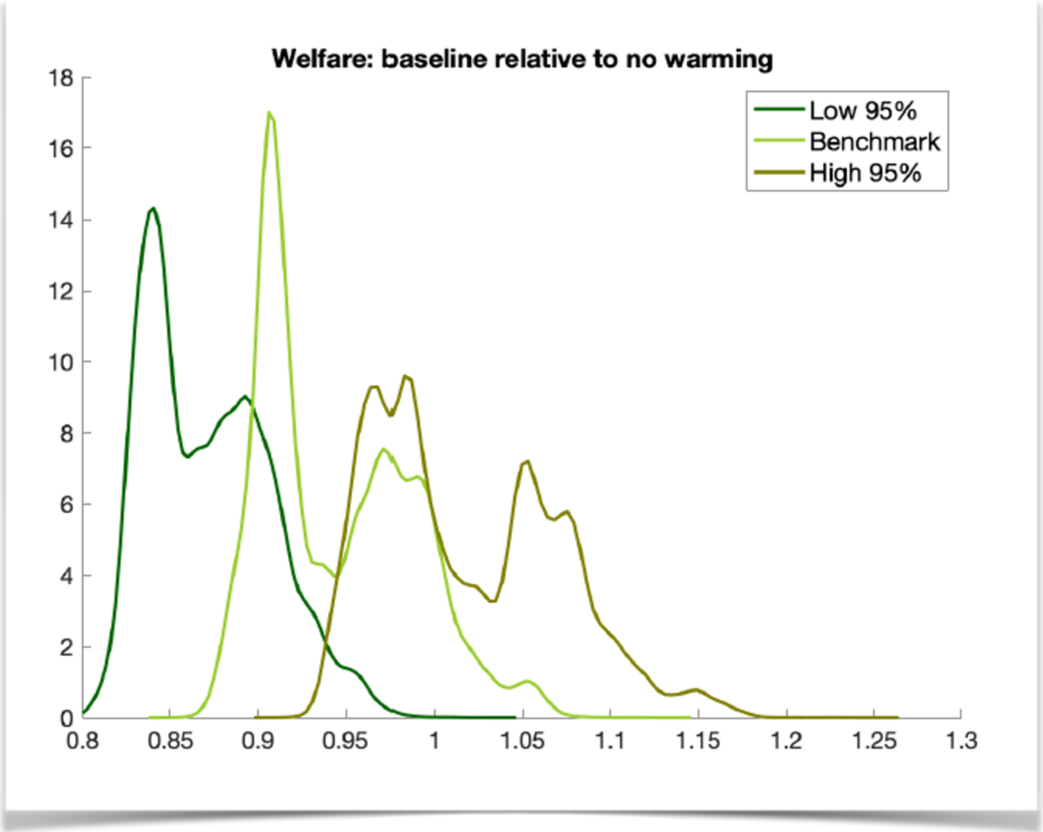


Large Uncertainty about Aggregate Economic Cost



By 2200 cost 95% confidence interval includes 0% and 20% aggregate welfare costs

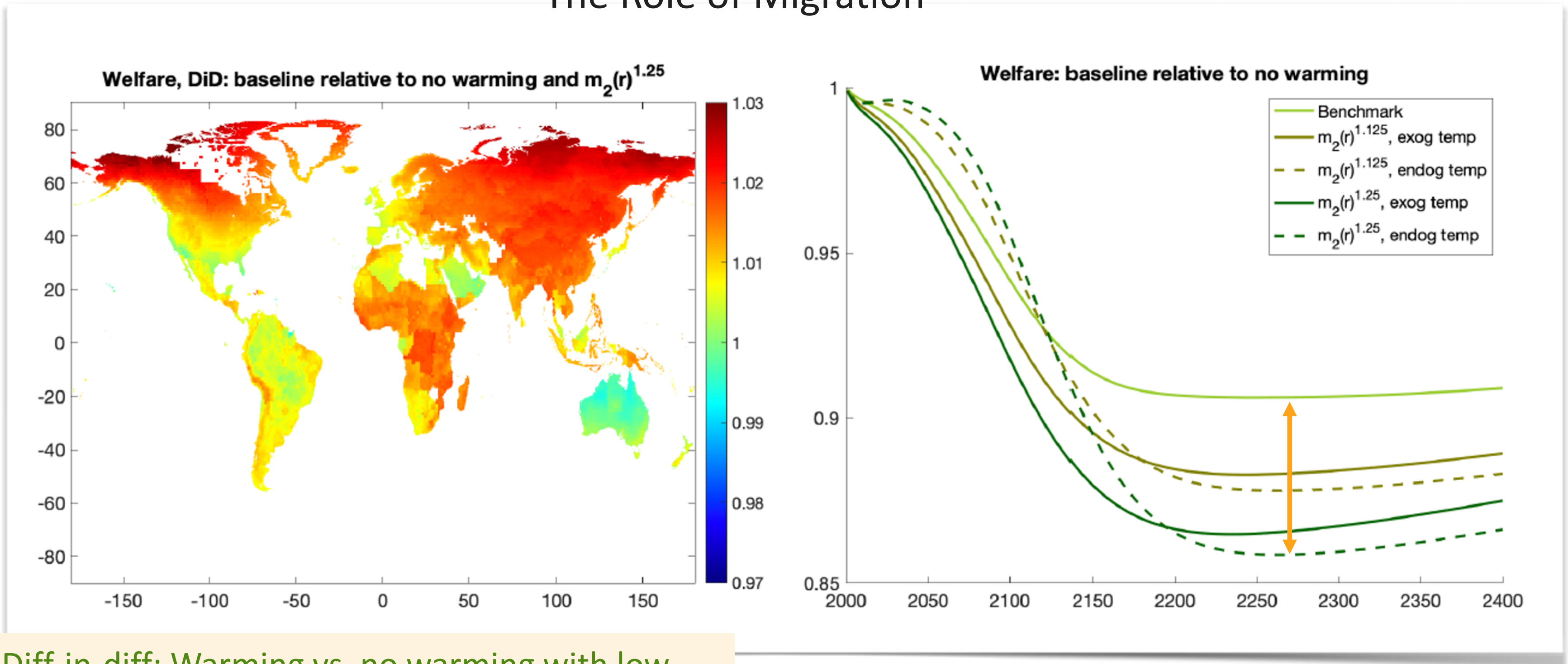
Range of distribution of cost and pattern similar for high and low damage scenarios



Adaptation and Spatial Behavioral Responses

Three key forms of adaptation: Migration, Trade, Innovation

The Role of Migration



Diff-in-diff: Warming vs. no warming with low vs. high migration costs

Red areas lose more/gain less with high migration costs

With 25% larger migration costs, impact of global warming about 1/3 larger

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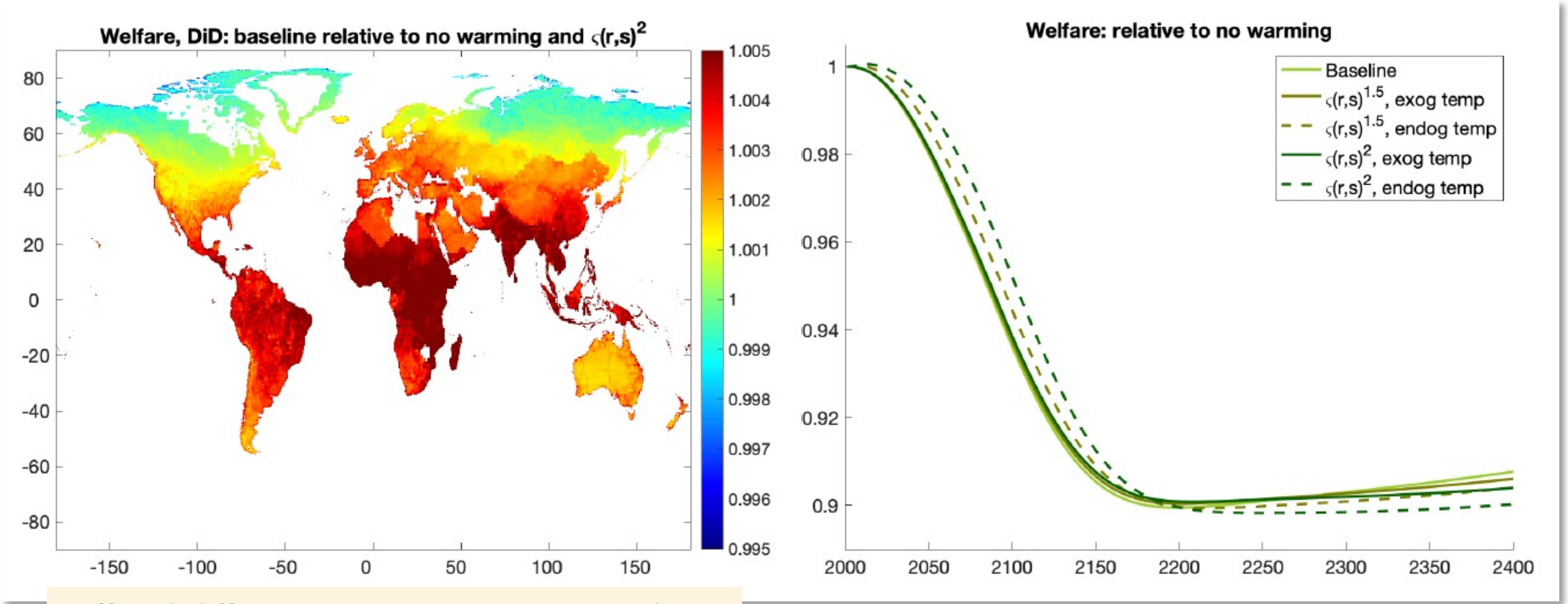


Diff-and-diff: Warming vs. no warming with low vs. high trade costs

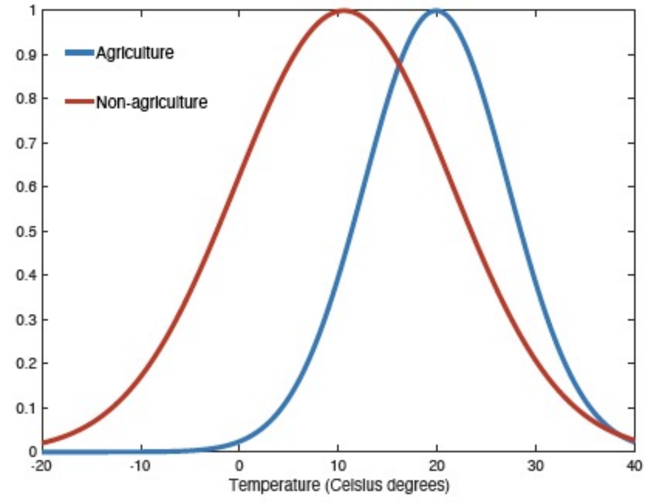
Red areas lose more/gain less with high trade costs

Higher trade costs have small effects on cost of global warming since distance is an important determinant of trade flows and climate effects are spatially correlated

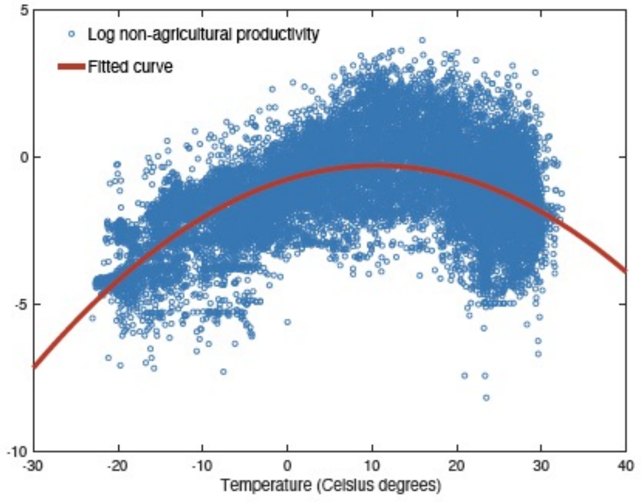
Adaptation and Spatial Behavioral Responses

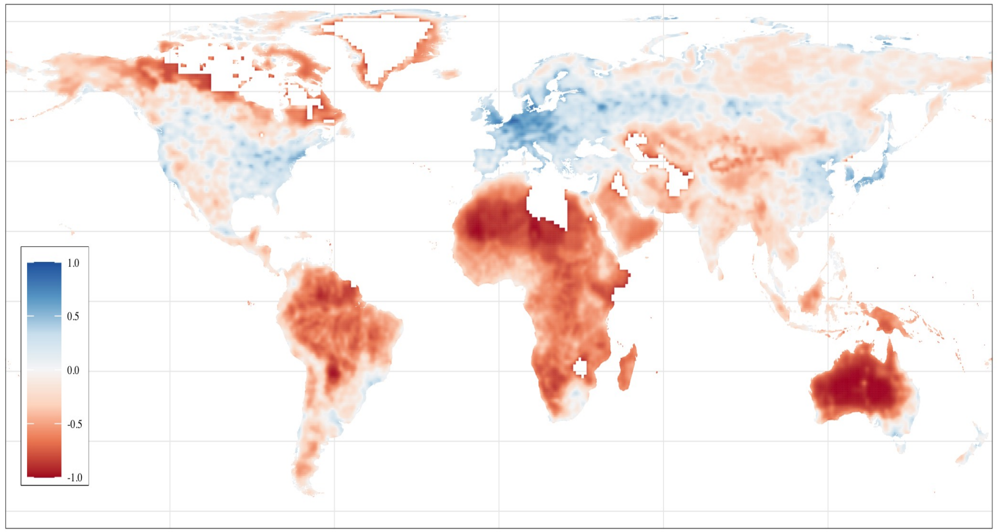
Effect of trade cost on adaptation much larger if climate change affects local comparative advantage. For example, affects agriculture more than other sectors. We study this in Conte et al. 2021.

Temperature productivity Discount



Non-Agricultural productivity and Temperature





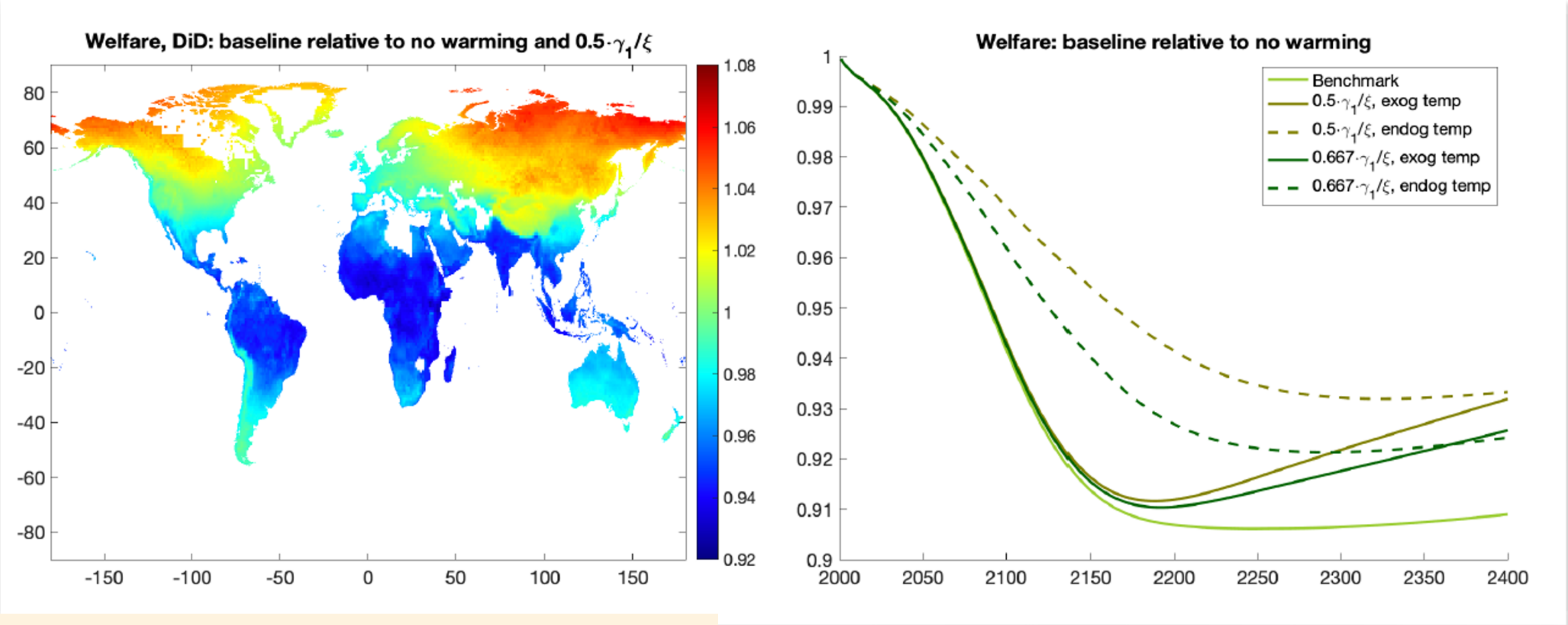
Temperature discount declines faster in agriculture as we move away from optimal temperatures

Larger trade costs change the geography of employment (changes by 2200)

Adaptation and Spatial Behavioral Responses

Three key forms of adaptation: Migration, Trade, Innovation

The Role of Innovation



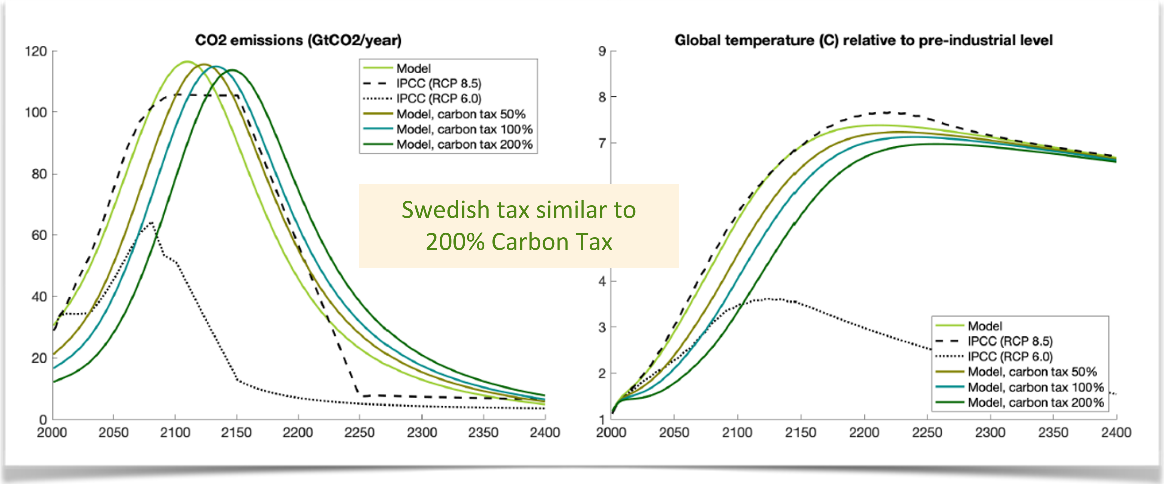
Diff-and-diff: Warming vs. no warming with low vs. high innovation costs

Red areas lose more/gain less with high innovation costs

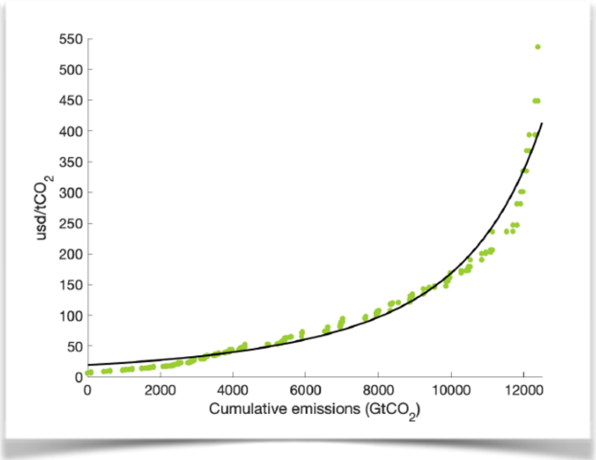
Higher innovation costs imply lower overall costs from global warming since less people move to India, China, and Africa which are badly affected

Carbon Taxes

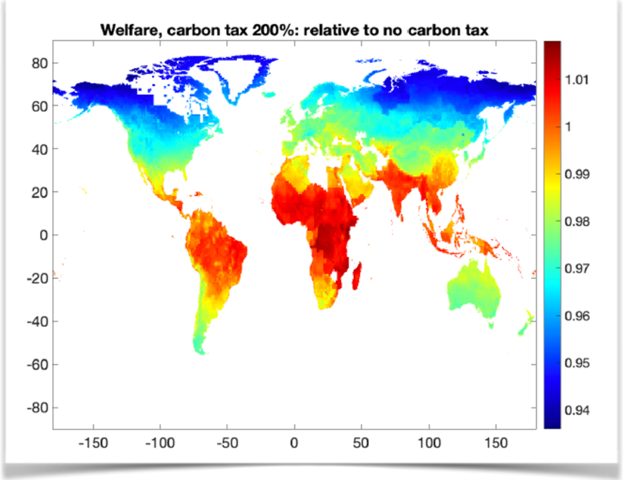
Main effect: Flatten the temperature curve and delay carbon consumption



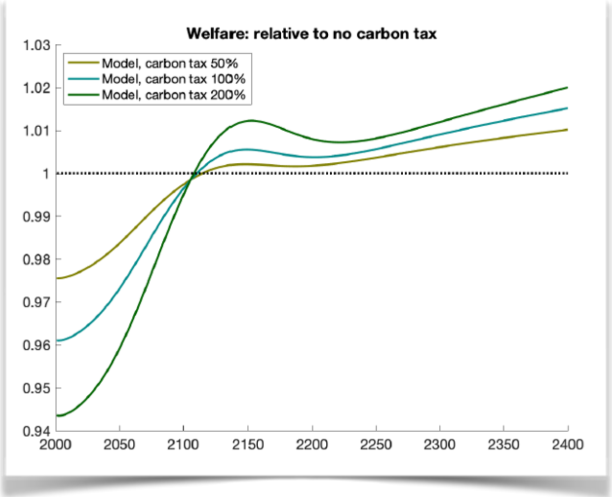
Swedish tax similar to 200% Carbon Tax



Extraction costs are convex, so less consumption today means lower costs in the future



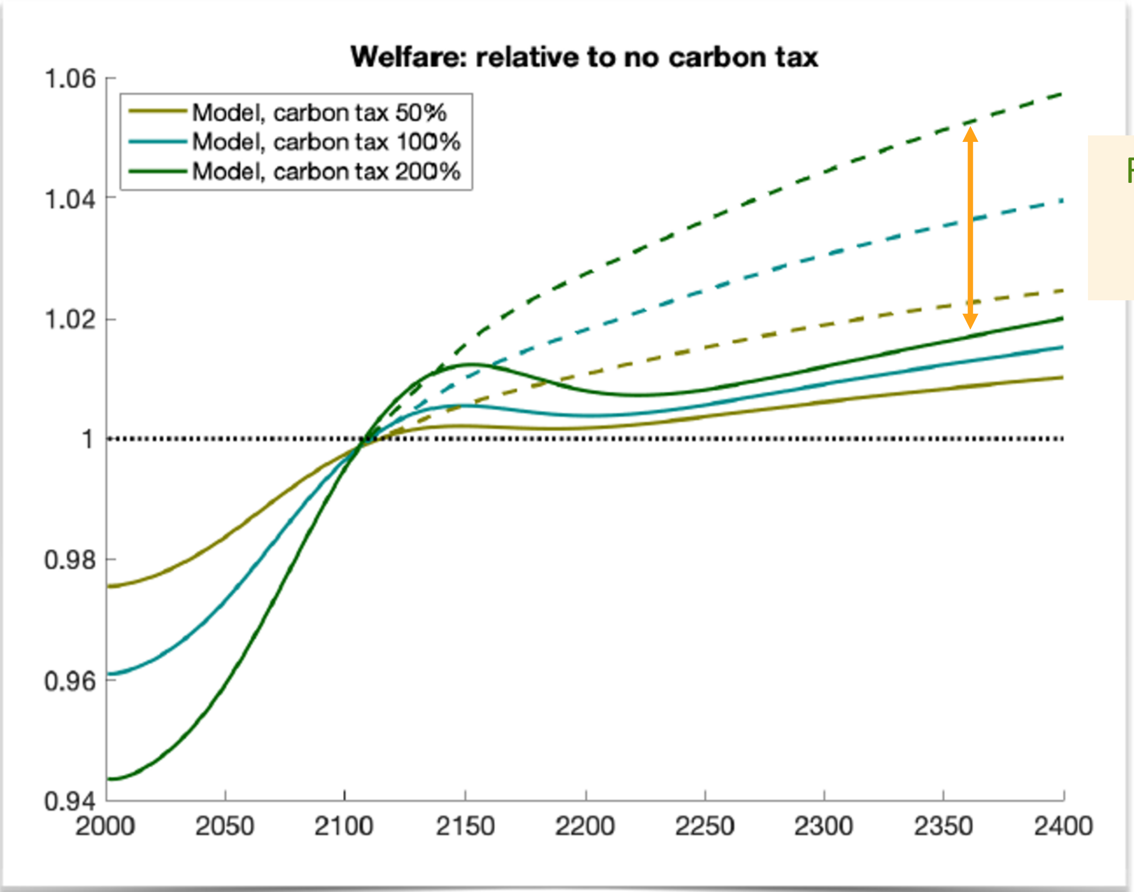
Most of the developing world's population gains from these policies: rich world pays but gets limited benefits



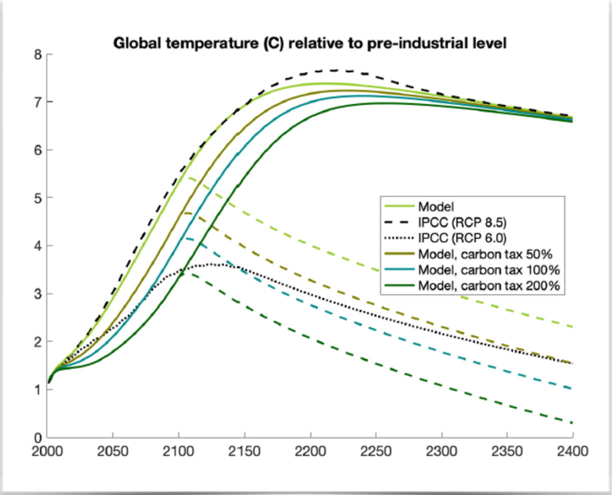
Policy implies current sacrifices for future gains: Discounting matters!

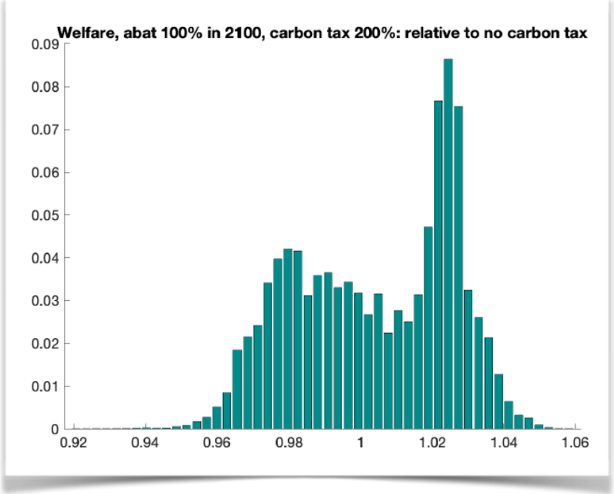
Carbon Taxes and Abatement

Much higher benefits when abatement technology forthcoming



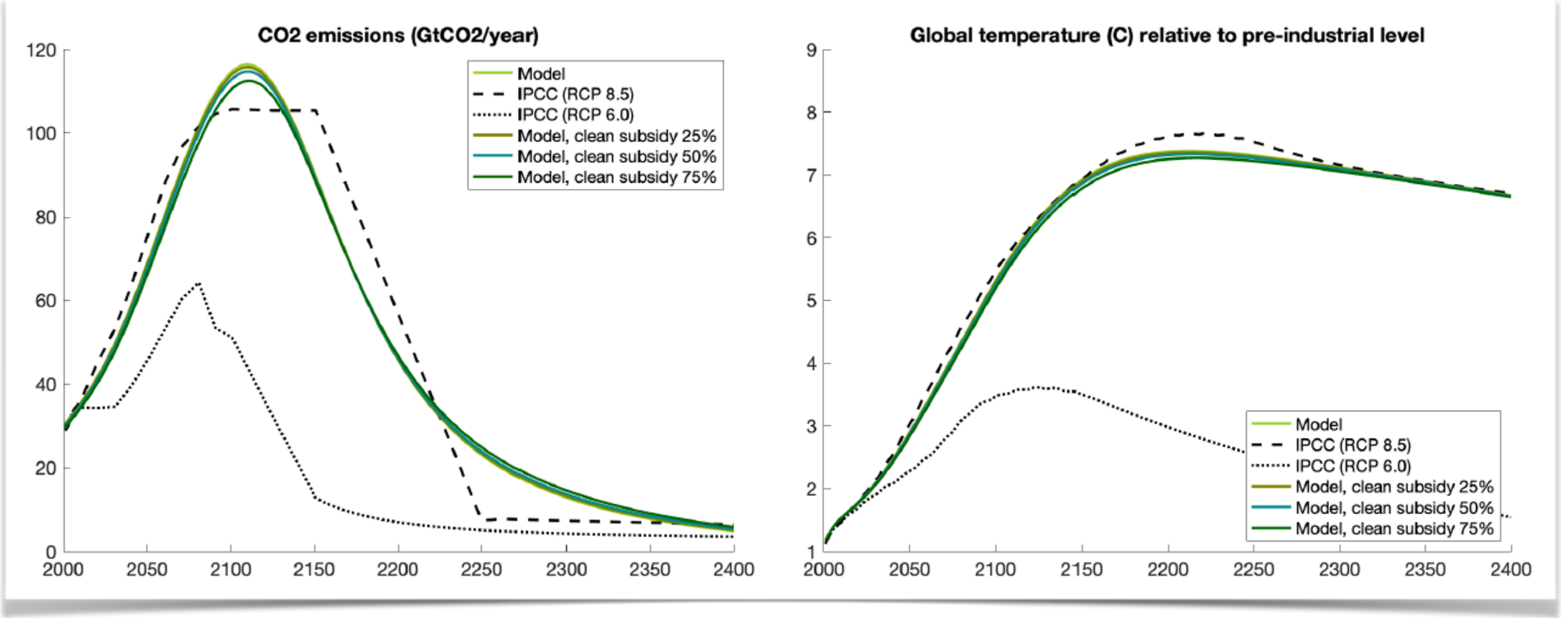
Role of perfect abatement technology in year 2100

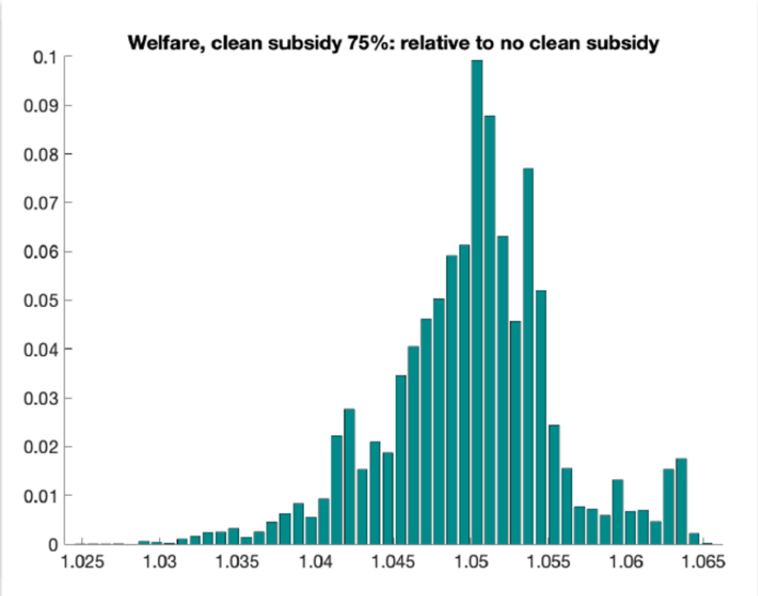




Clean Energy Subsidies

Main Effect: Reduce relative carbon use, but increase total energy consumption





Small effect on emissions or temperature

Welfare effects of a 75% subsidy are large but for the “wrong” reasons: Like a production subsidy

Basic Takeaways

- Important to evaluate cost of phenomena in order to determine policy priorities

- Climate change generates heterogenous effects across space
  - Adaptation and spatial frictions matter for costs
  - Cost is much larger in poorest regions

- Carbon taxes "flatten the curve" but might not eliminate total carbon use
  - Important to invest in abatement technology and carbon substitution