Spatial Adaptation to Climate Change

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(based on work with Conte, Cruz, Desmet, and Nagy)

Climate Change: Implications for Macroeconomics
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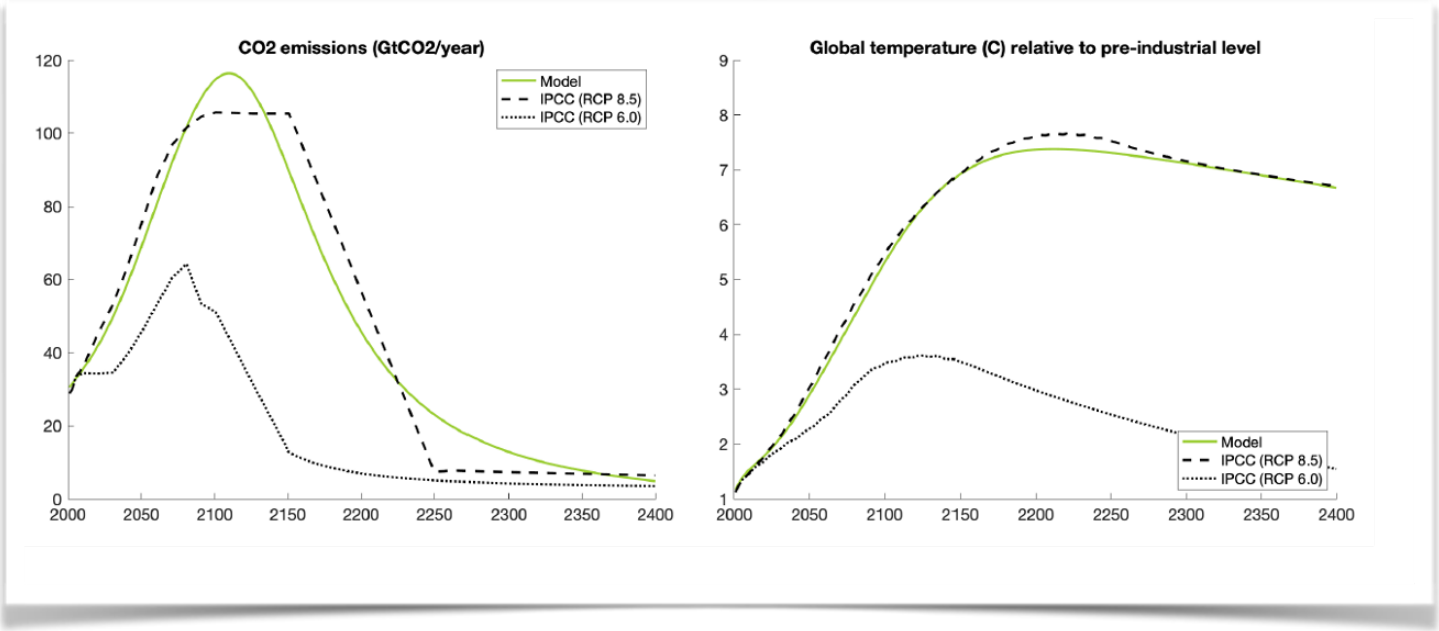
Introduction

- Climate change is happening, and it will be hard to stop anytime soon
  - Policy, and policy consensus, is far from where it needs to be to achieve temperature goals
- Economy will need to adapt to minimize the costs
- Costs are associated with the cost of changing the location of economic activity:
  - Spatial frictions (trade, migration, investment, changes in specialization)
  - Costs and benefits from density (agglomeration and congestion forces)
- Heterogenous impact across locations implies that there will be winners and losers
- Need to design policy that considers adaptation across locations and sectors
  - First step: develop assessment models that are global, dynamic, and have spatial heterogeneity

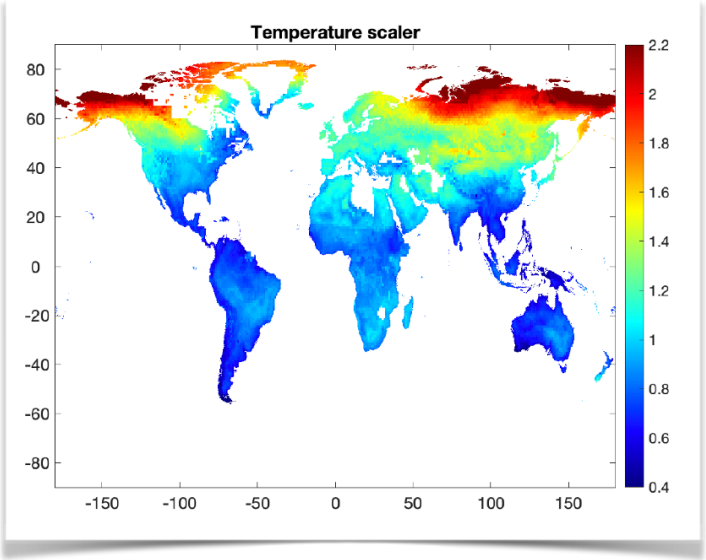
Evaluating the Economic Cost of Global Warming

- Need to incorporate in the analysis many locations and the ability to shift location of economic activity
- Need behavioral model of agents' actions: Hard to extrapolate empirically (new reality and long periods)
- Emphasize role of innovation/investments, mobility (and fertility and mortality), and trade

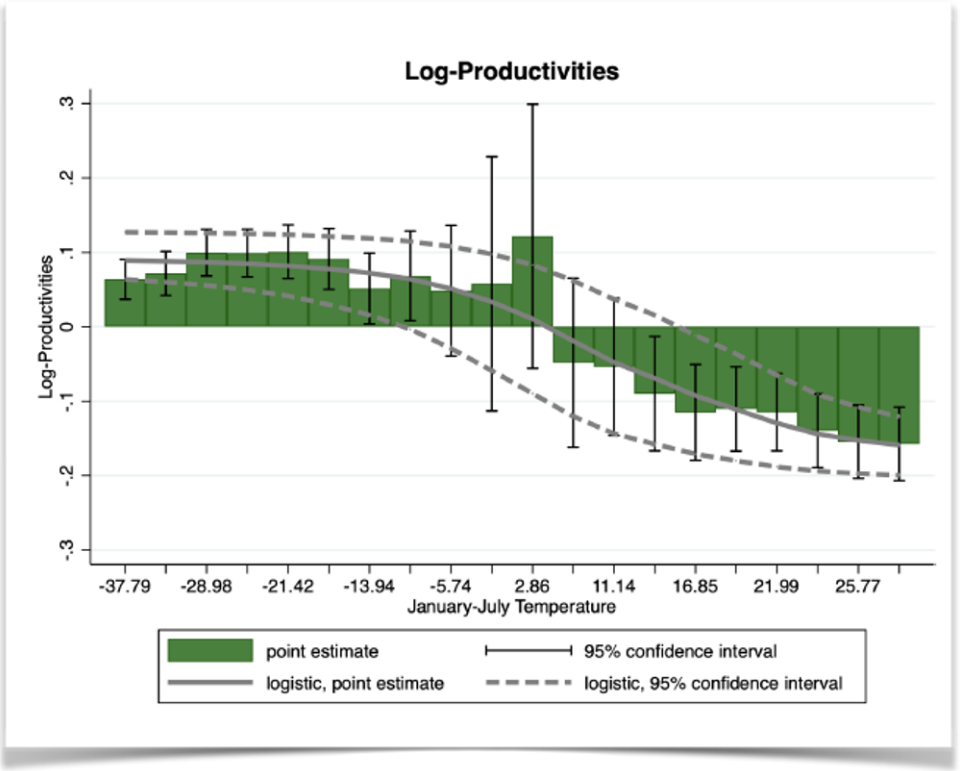


Climate change scenario depends on agents' actions plus assumptions on total stock of carbon and energy share in production (4%)

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



Damage Functions for Productivities and Amenities

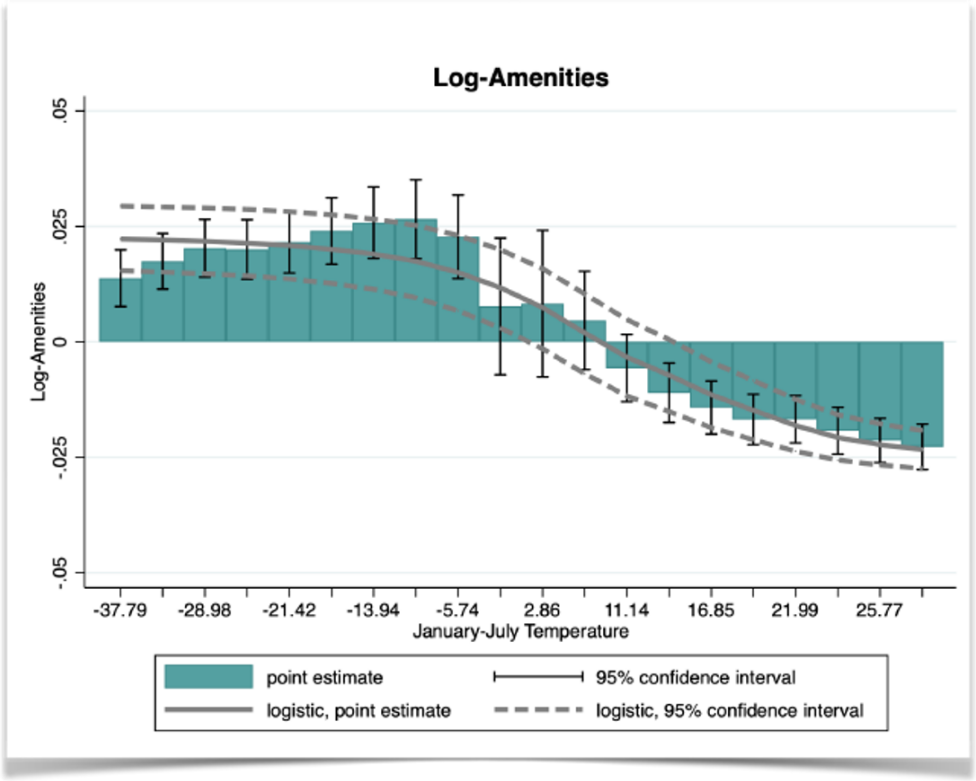


After controlling for other sources of changes (innovation, migration, trade), local natural attributes, plus year-region fixed effects

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

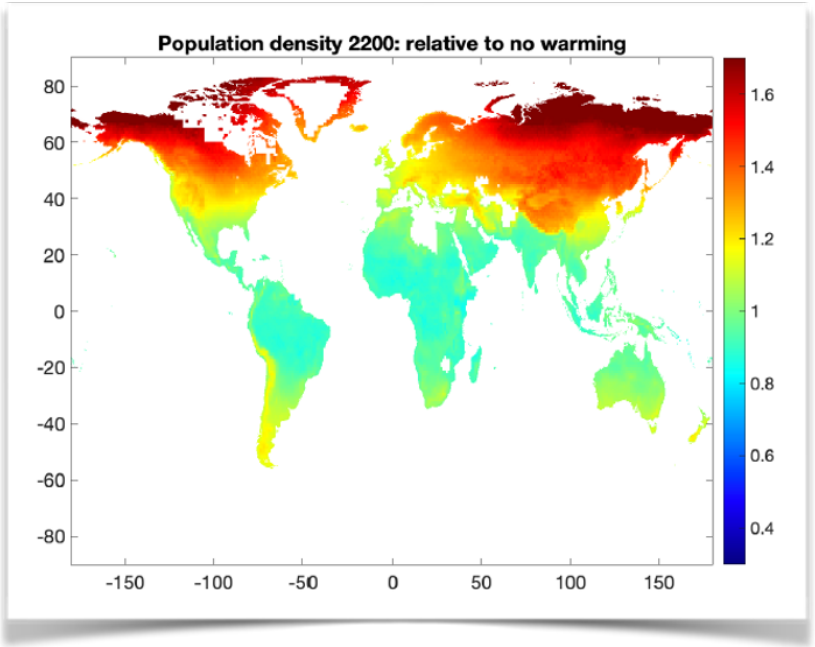
Shows the semi-elasticity of productivity and amenities to increases in temperature: % change from an additional °C

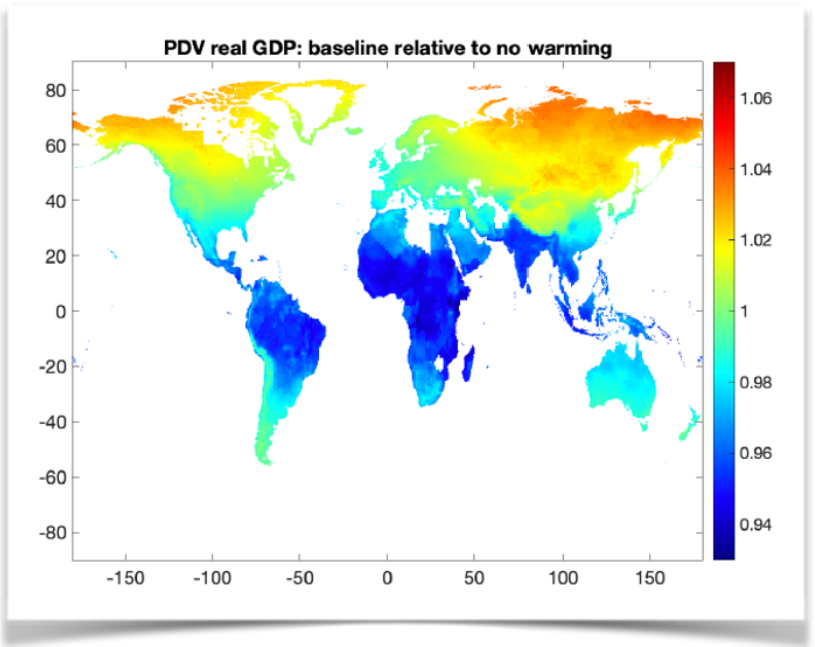
Effect varies by current temperature

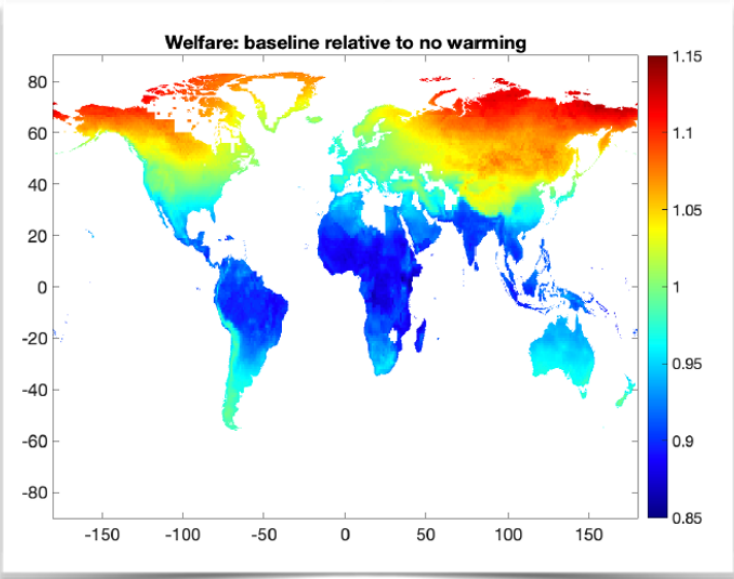


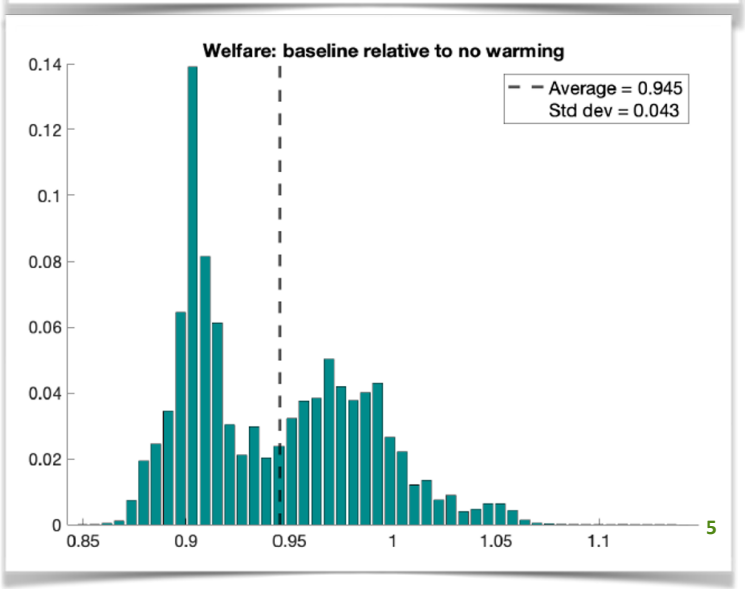
Estimates of the Local Economic Cost of Global Warming

- Calculate the dynamic effect on location, real GDP, and welfare



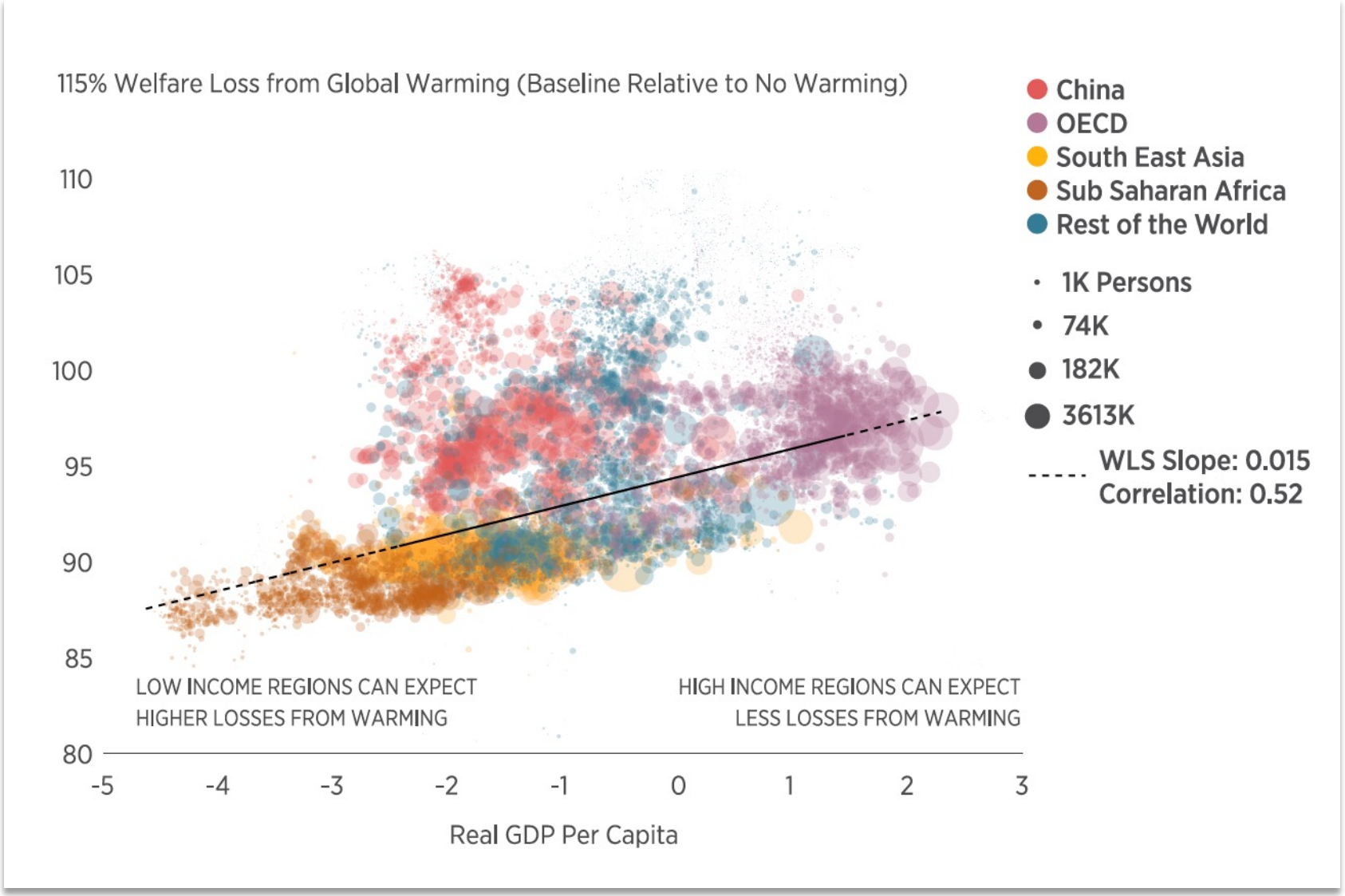




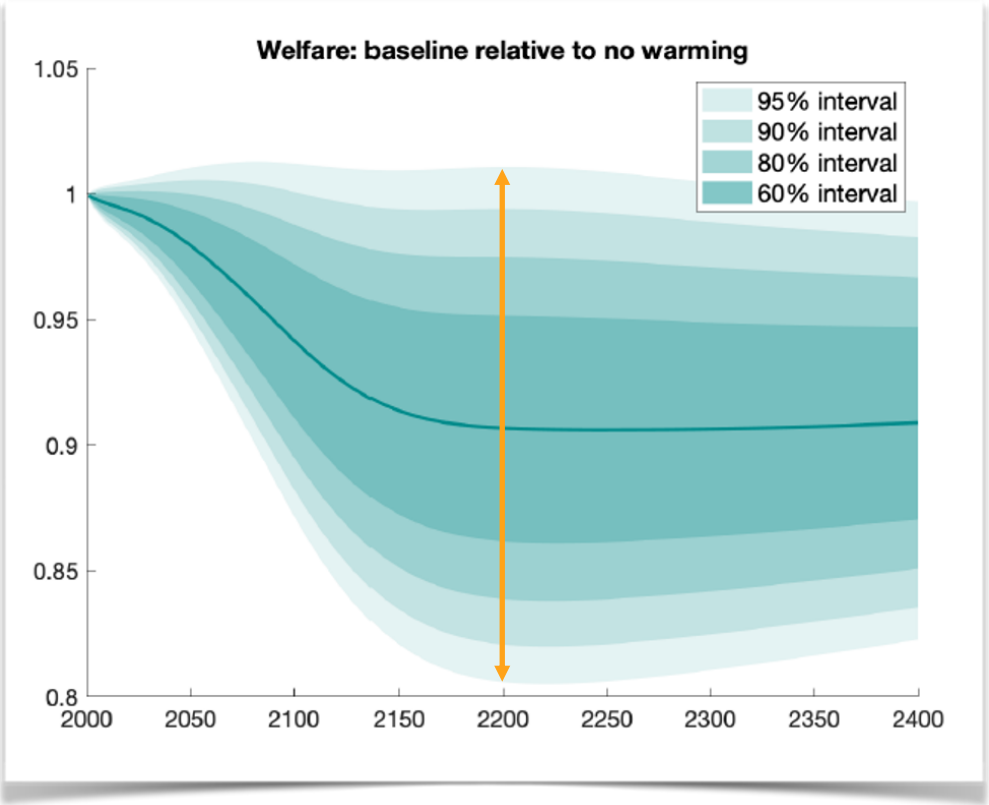


Effect on welfare larger than effect on GDP due to deterioration of amenities

Global Warming and Inequality

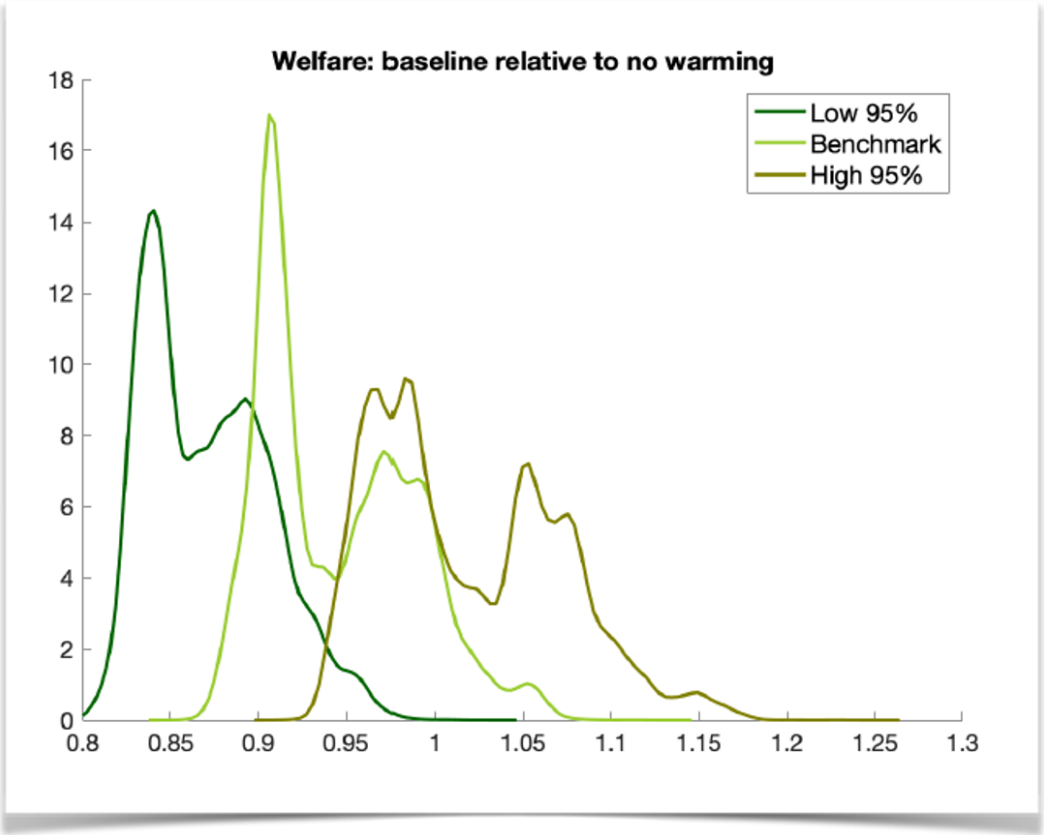


Large Uncertainty about Aggregate Economic Cost



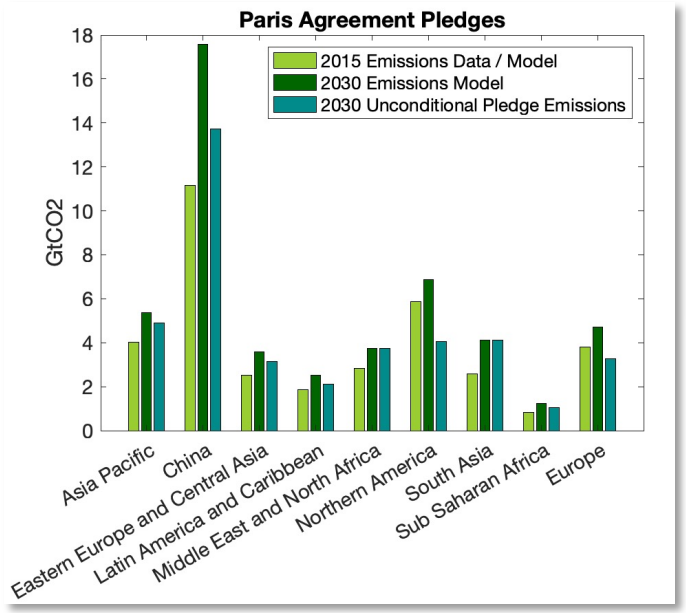
By 2200 cost 95% confidence interval includes 0% and 20% aggregate welfare costs

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

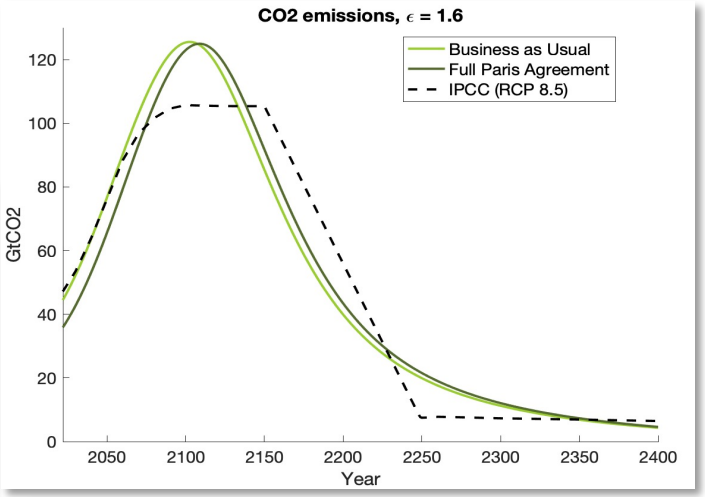


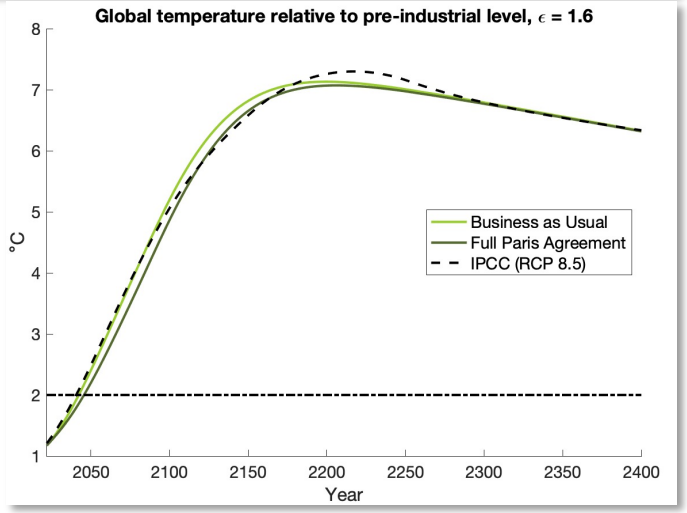
Carbon Policy is Unlikely to Stop Global Warming Soon

- Paris Agreement far from being sufficient to implement temperature goals



The Paris Agreement has only minor effects on emissions and temperatures



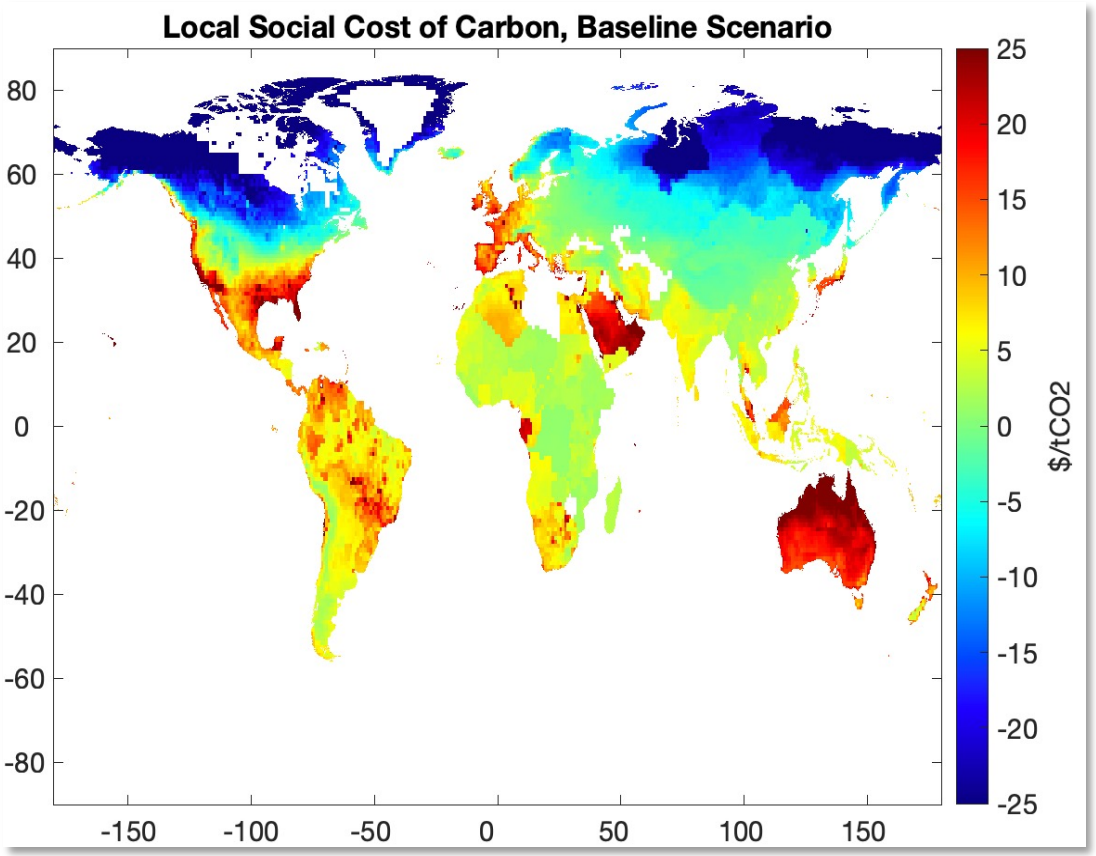


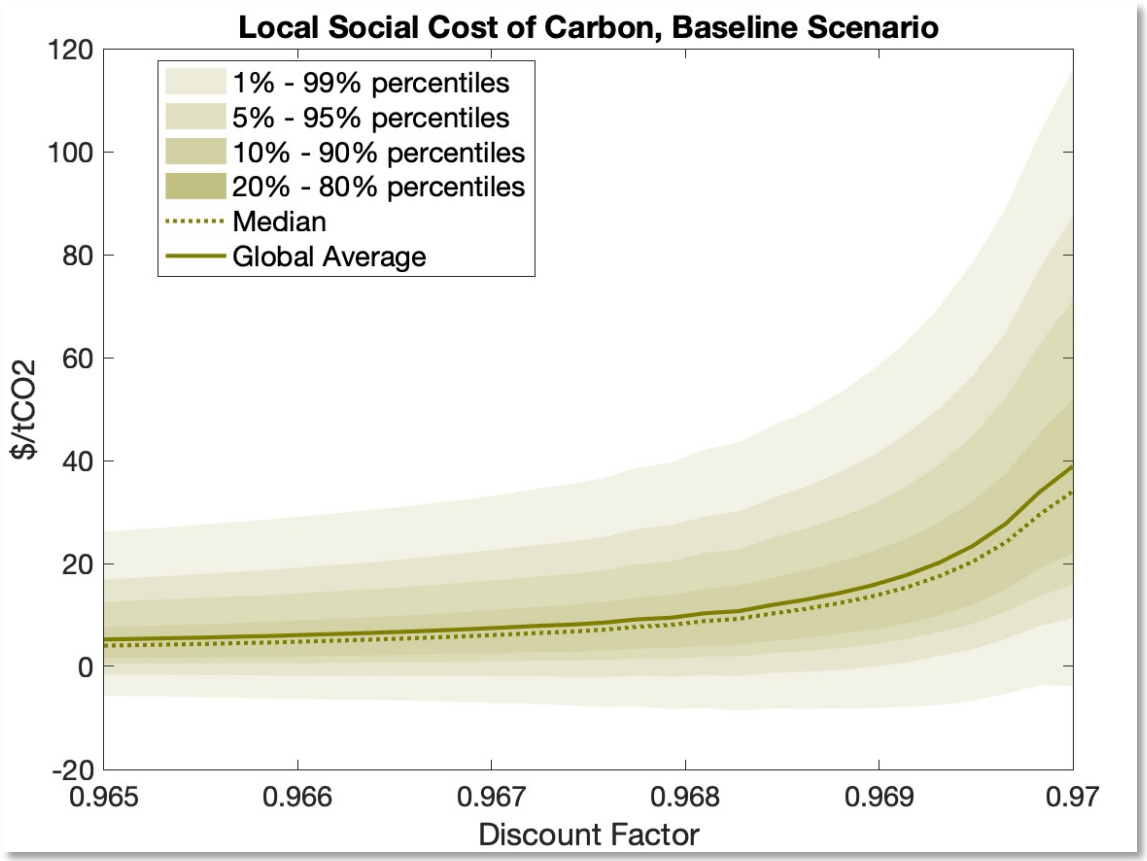
Region	Carbon Tax ($/tCO$_2$) $\epsilon = 1.6$ 2050	$\epsilon = 1.6$ 2100	$\epsilon = 3$ 2050	$\epsilon = 3$ 2100
Asia Pacific	25.91	474.65	23.88	243.33
China	42.41	553.86	39.11	256.89
Eastern Europe and Central Asia	29.45	482.44	24.15	212.46
Latin America and Caribbean	34.53	497.19	17.90	171.65
Middle East and North Africa	17.18	450.17	18.14	302.50
Northern America	78.86	708.74	53.20	222.49
South Asia	17.10	433.45	17.68	236.25
Sub Saharan Africa	33.33	515.52	29.26	280.22
Europe	57.58	601.26	32.97	199.32
Global Average	**32.85**	**505.59**	**27.38**	**240.68**

Large taxes needed for global temperatures to stay below 2°C by 2100

Location's Disagree About Size of Optimal Taxes

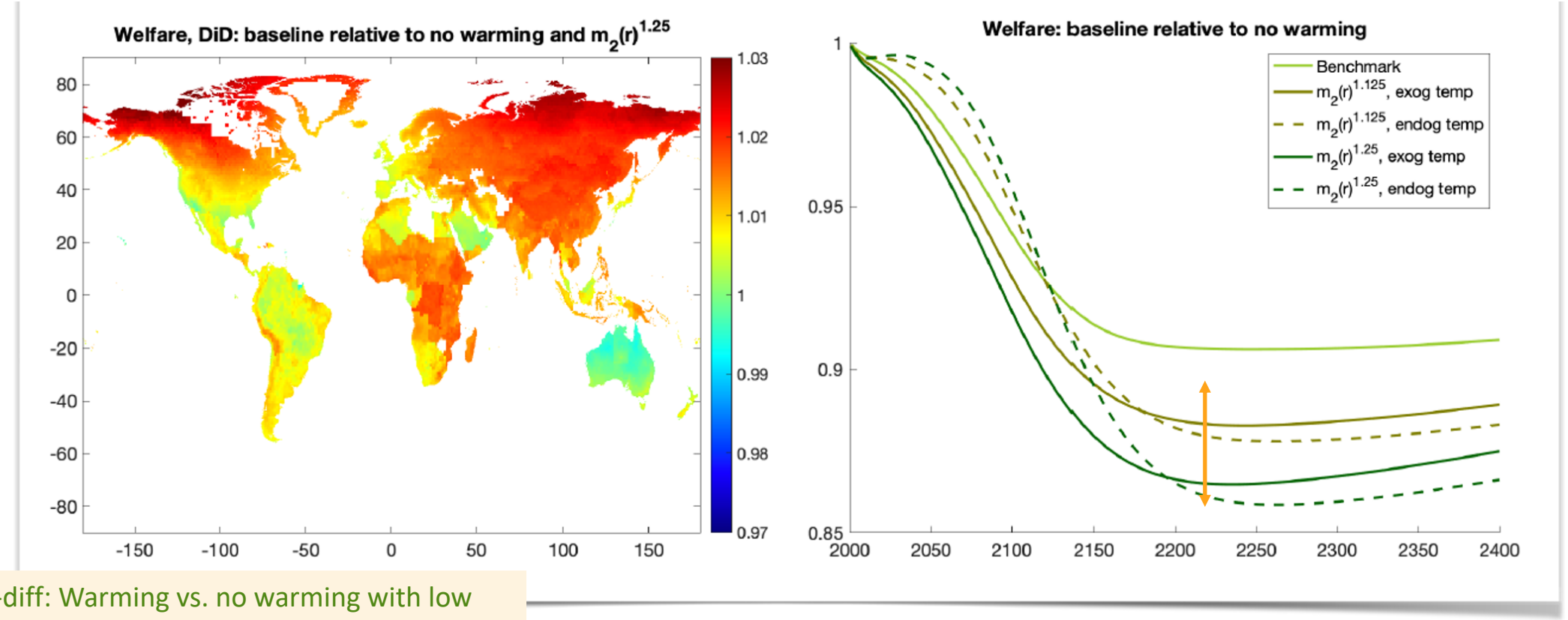
- The Local Social Cost of Carbon
- Interpretation: The carbon price a location would like to impose on the world





Adaptation and Spatial Responses: Migration

- Migration will be an important source of adaptation: Particularly in Africa, Southeast Asia, Central America



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

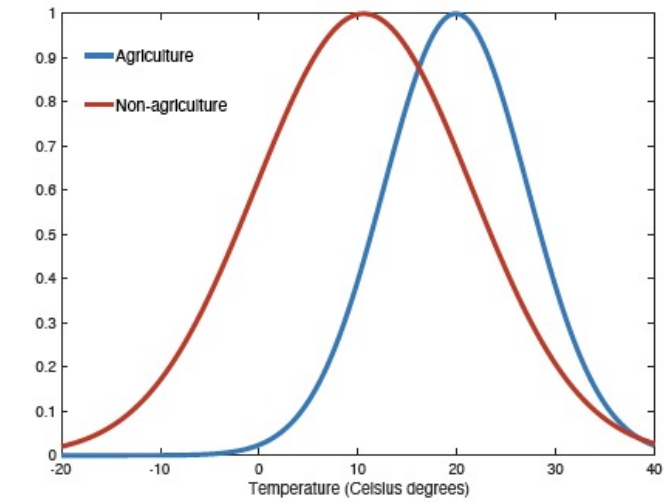
Red areas lose more/gain less with high migration costs

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

Adaptation and Spatial Responses: Trade

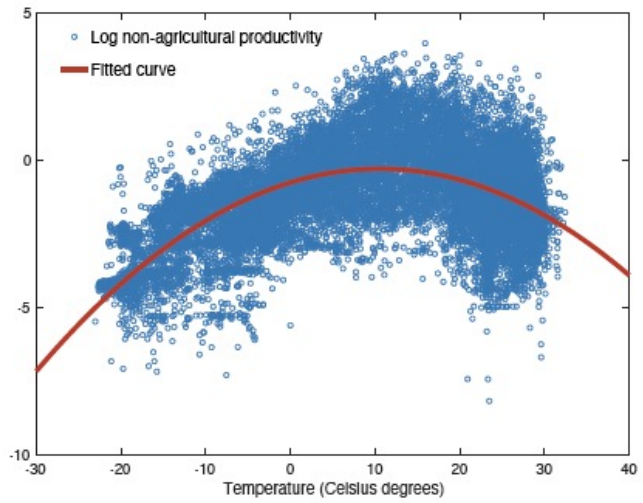
- Effect of trade cost on adaptation large if climate change affects local comparative advantage
- Trade and migration are substitutes in adaptation

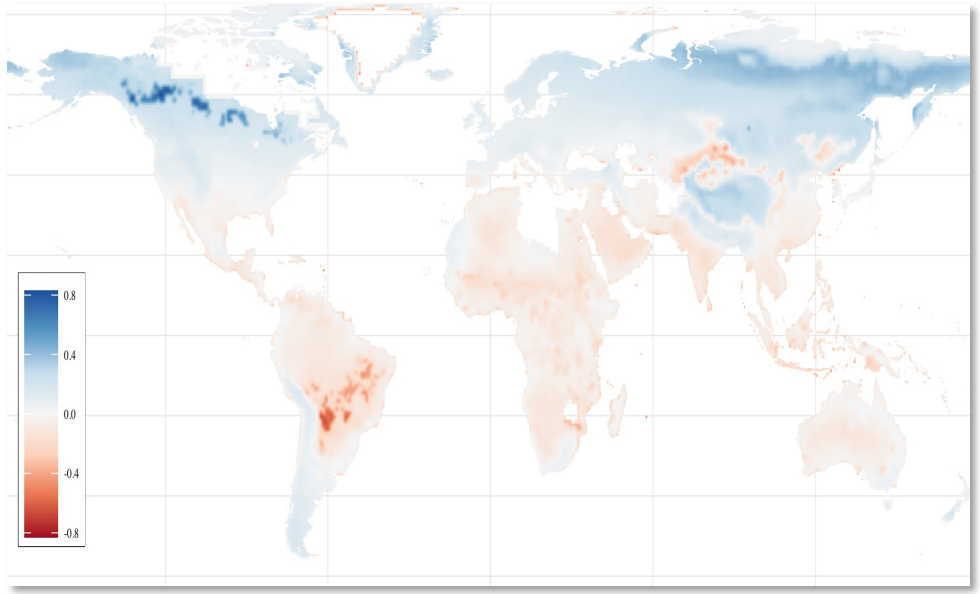
Temperature productivity Discount



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

Non-Agricultural productivity and Temperature





Larger trade costs imply more mobility towards northern latitudes

Takeaways

- Prepare for global warming
  - Protracted but has the potential to change spatial distribution and specialization patterns
  - Current policy will not stop global warming, large disagreement in costs
- Simplify adaptation: Migration costs, trade cost, elasticity of substitution
  - Migration and trade are substitutes
  - Important to facilitate transitions to northern latitudes through innovation and investments
- Large uncertainty, but perhaps less about range and location of spatial costs