Climate and the Economy

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Outline

1) Obvious things that we know

2) Less obvious things that we know

3) Why we may never know climate damages

4) Damages from climate change to date

5) Can use markets to project damages?

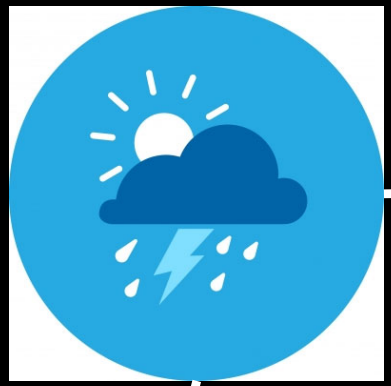
1) Obvious Things We Know

1a) Adaptation partially offsets the consequences of weather

Forecast

Weather

Impacts

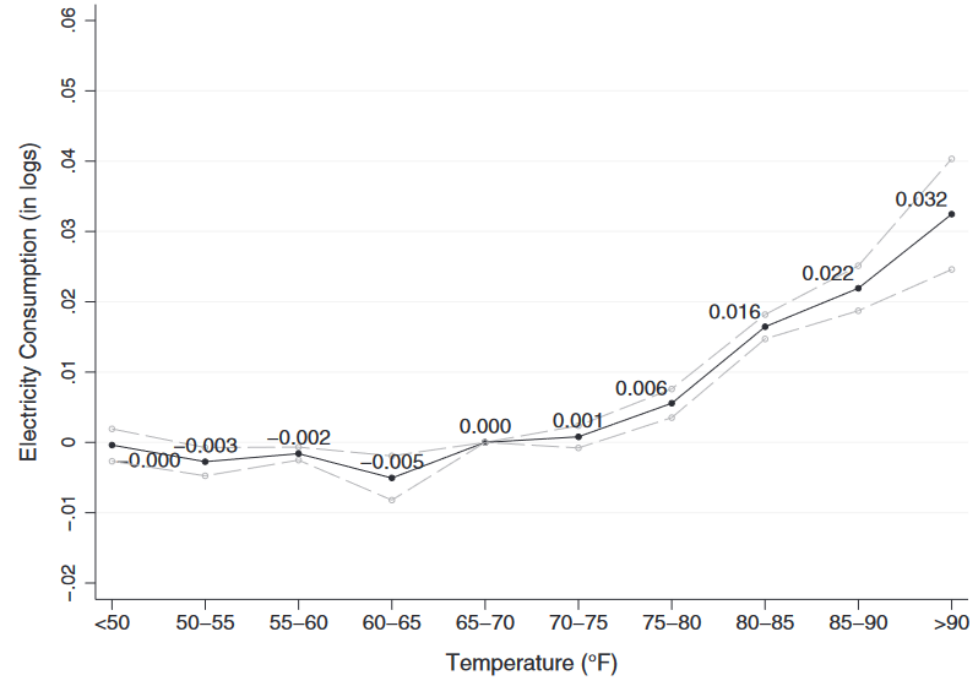


Ex-Post Adaptation

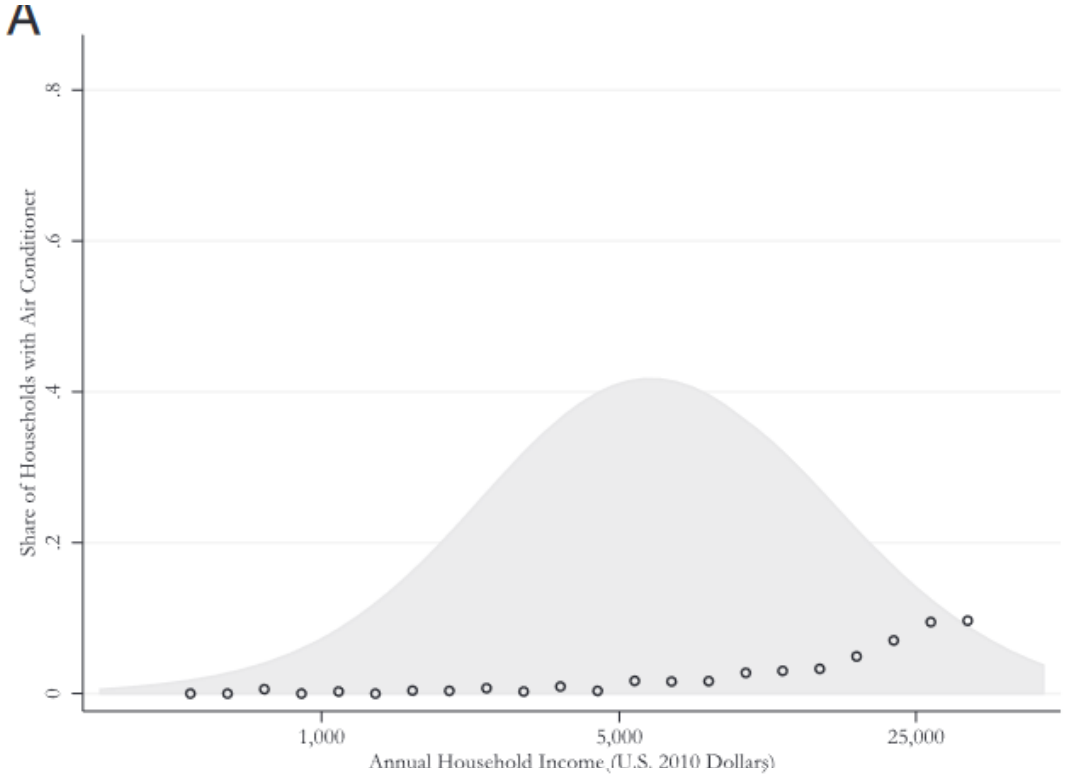
Ex-Ante Adaptation

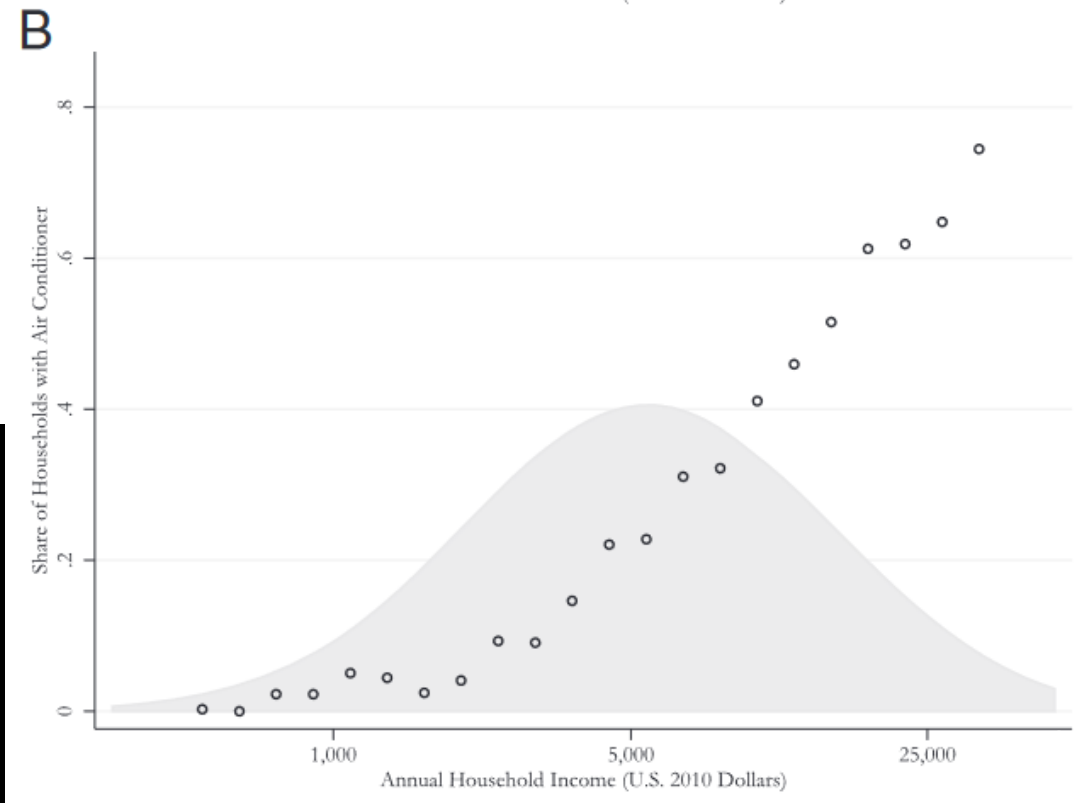
1a) Illustrating with air conditioning

Ex-Post



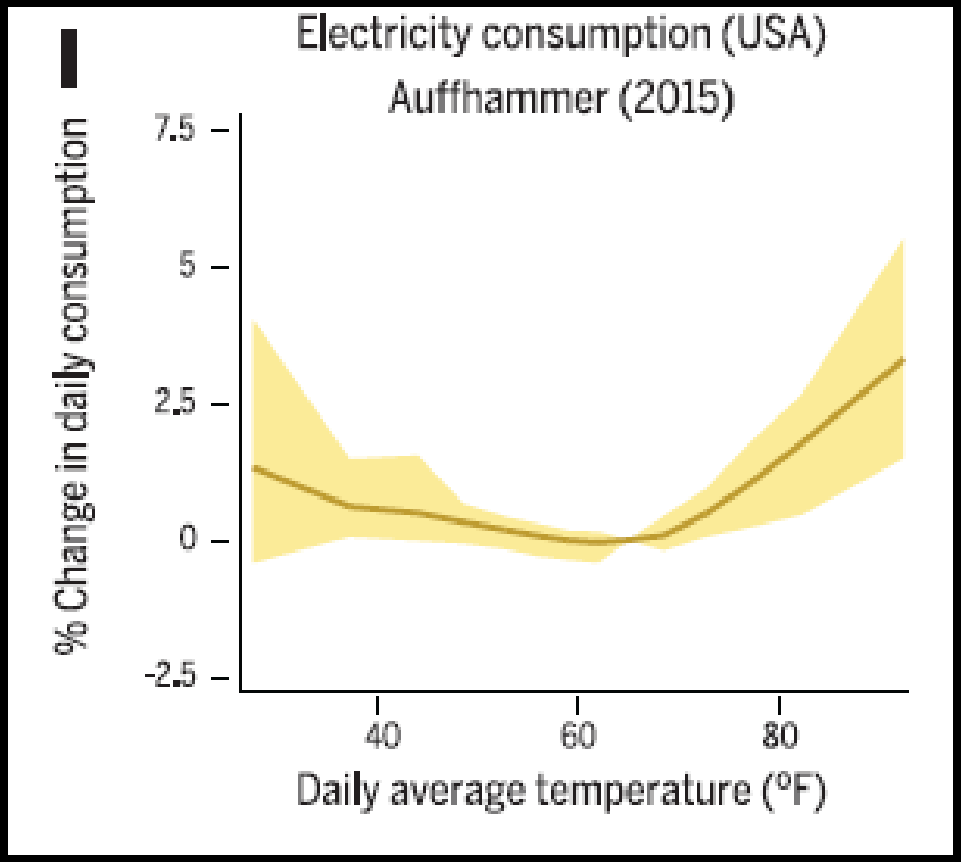
Ex-Ante





Davis and Gertler (2015)

1b) But adaptation has costs, too



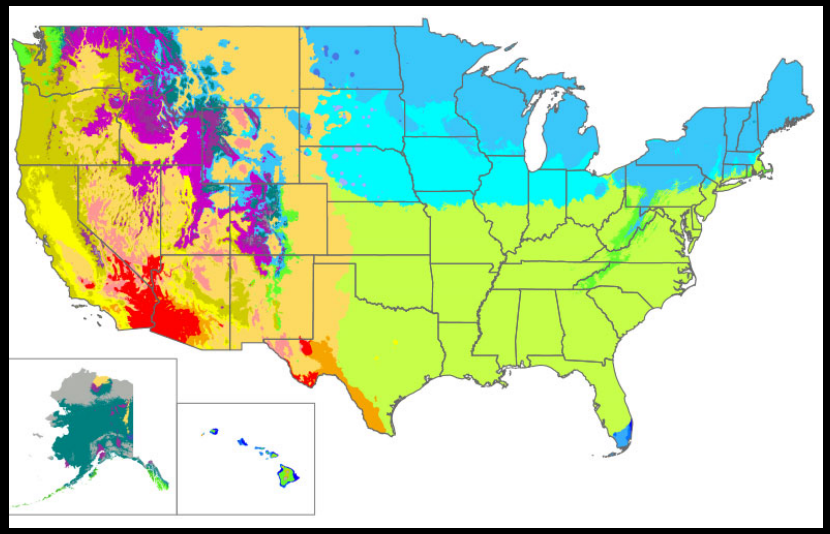
via Carleton and Hsiang (2016)

Davis and Gertler (2015)

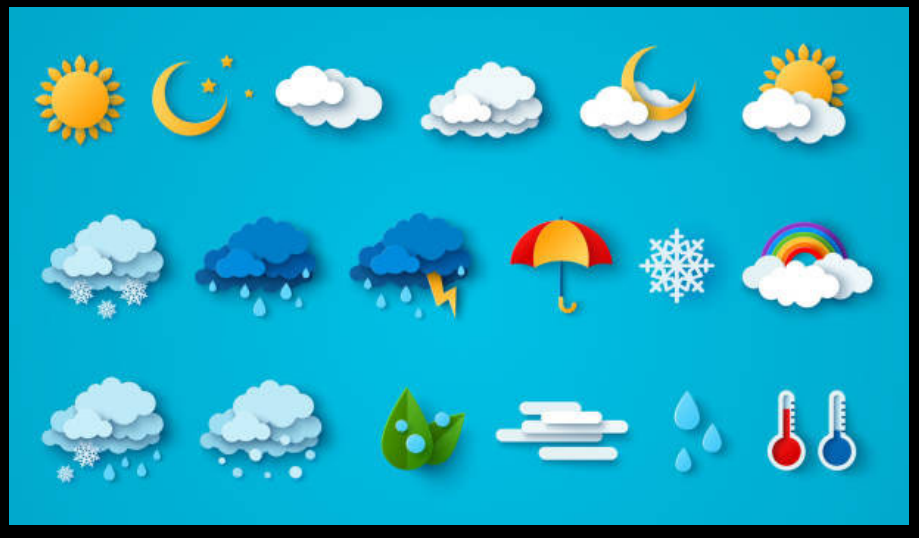
Table 1. End-of-century predictions (for Mexico)

Greenhouse gas concentration trajectory	Households with air conditioning, %	Change in residential electricity consumption (compared with 2010), %	Total change in annual electricity expenditure (US 2010 dollars, millions)	Total change in annual carbon dioxide emissions, millions of tons
		Intensive margin only		
RCP 4.5	13	7.5	$357	2.7
RCP 8.5	13	15.4	$733	5.5
		Intensive and extensive margins, with 2% annual income growth		
RCP 4.5	71	64.4	$3,065	23.1
RCP 8.5	81	83.1	$3,955	29.8

1c) We cannot just compare hot and cold places to learn about importance of climate



1d) We can learn about the importance of weather



2) Less Obvious Things We Know

2a) Responses to changing weather are not the same as responses to changing climate

i) Capital adjusts only slowly

->We might do more in response to climate than weather!

ii) Resources get depleted over time

->We might do less in response to climate than weather!

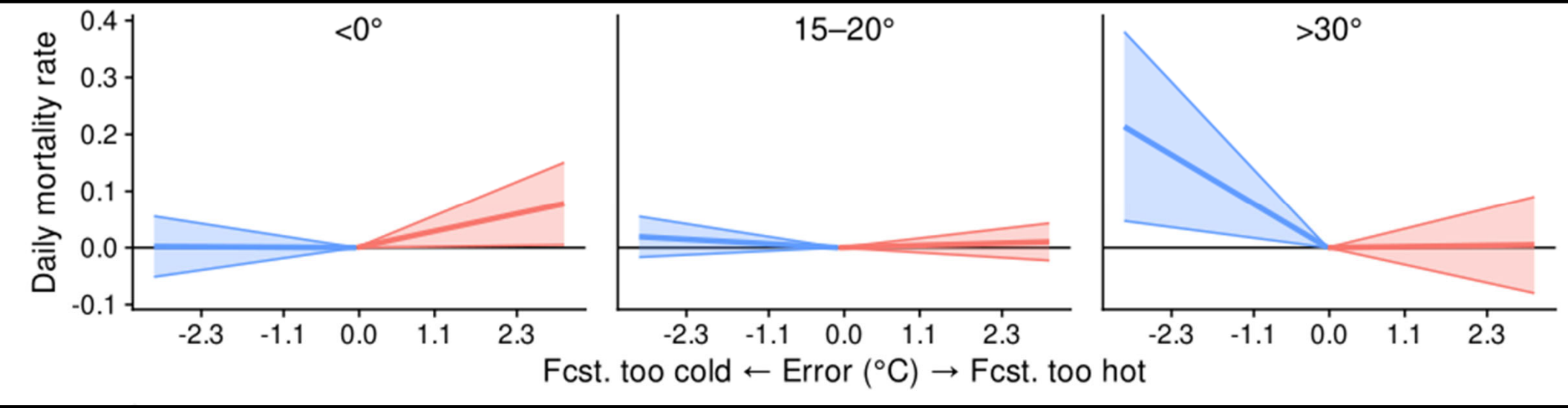
iii) We have knowledge of climate much farther in advance

->Ex-ante adaptation can take the form of long-run investments

iv) Climate affects everywhere at once

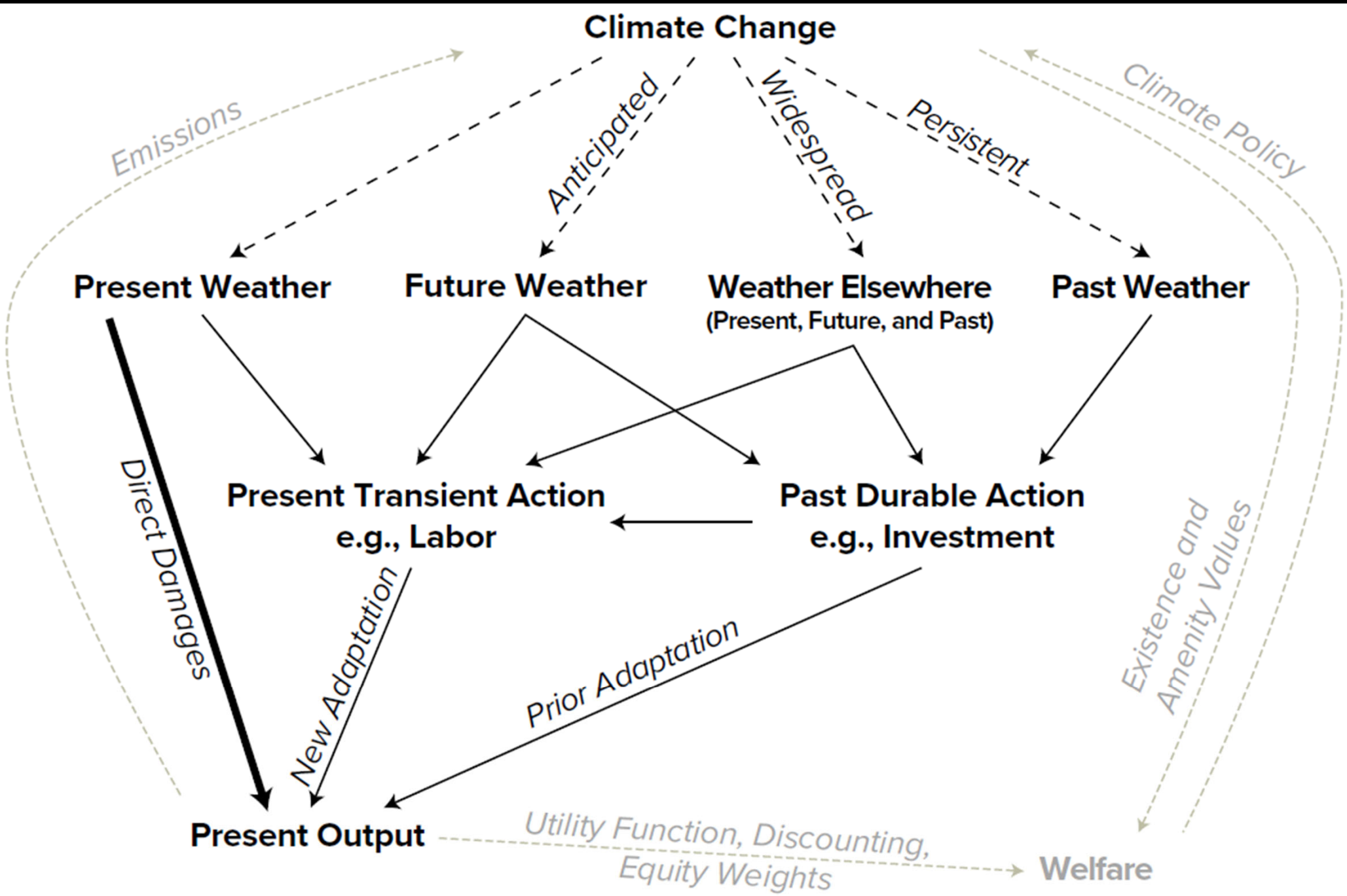
->“General equilibrium” channels (altered trade, new supply, etc) more important for climate

2b) Adaptation is really important



Shrader, Bakkensen, and Lemoine (2023)

3) Why we may never know climate damages


Climate Change
Emissions
Anticipated
Widespread
Persistent
Climate Policy
Present Weather
Future Weather
Weather Elsewhere
(Present, Future, and Past)
Past Weather
Direct Damages
Present Transient Action
e.g., Labor
Past Durable Action
e.g., Investment
New Adaptation
Prior Adaptation
Existence and
Amenity Values
Present Output
Utility Function, Discounting,
Equity Weights
Welfare

Climate Impacts Trilemma

Researchers estimating climate impacts can have at most two out of:

i) Robustness to economic model structure

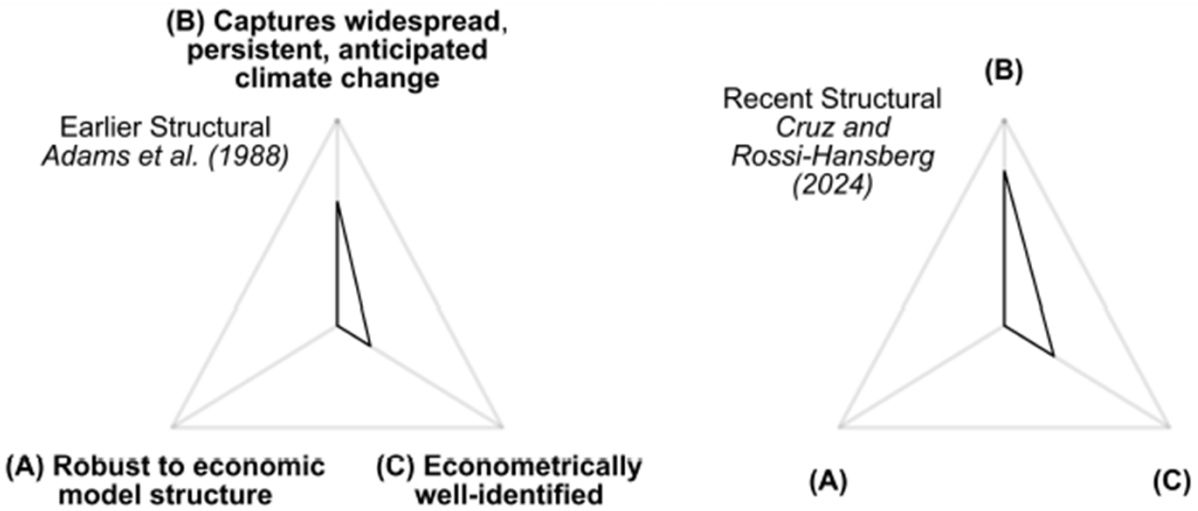
Not overly reliant on particular assumptions

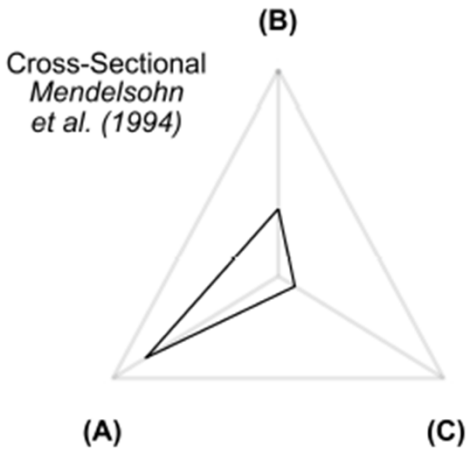
ii) Interpretable as effect of widespread, persistent, anticipated climate change

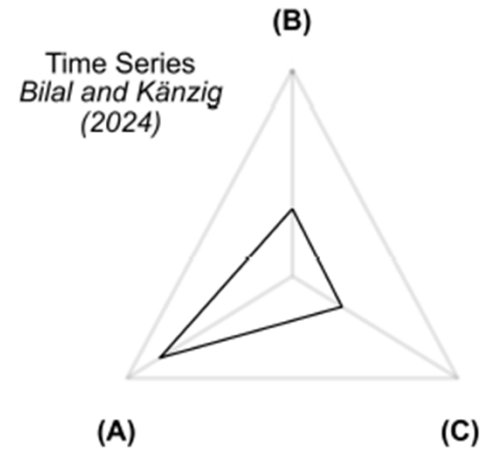
Not just effects of local, current weather

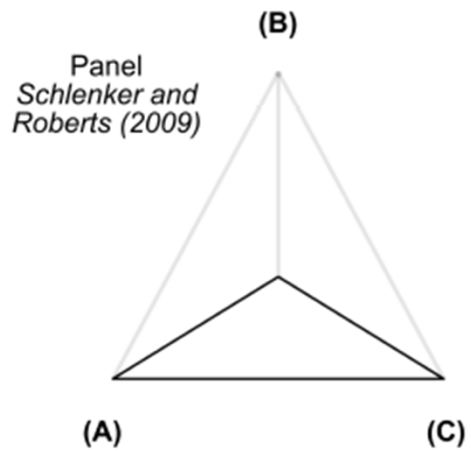
iii) Econometrically well-identified

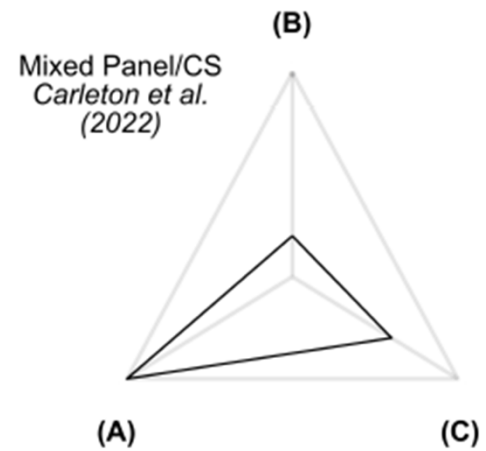
Capture clear causal effects











Lemoine, Hausman, and Shrader (2026)

4) Damages from climate change to date (Lemoine 2025, *PNAS*)

Should be more feasible to estimate recent losses than to project future losses.

1) Technologies and economic structures are similar to:
i) what would have been without climate change, and
ii) what were in estimation period

- Whereas to project future damages, must project weather-economy relationships out of sample

2) Linear effects may suffice

- Whereas to project future damages, need worry about nonlinear effects (without data to pin down nature or degree of nonlinearity)

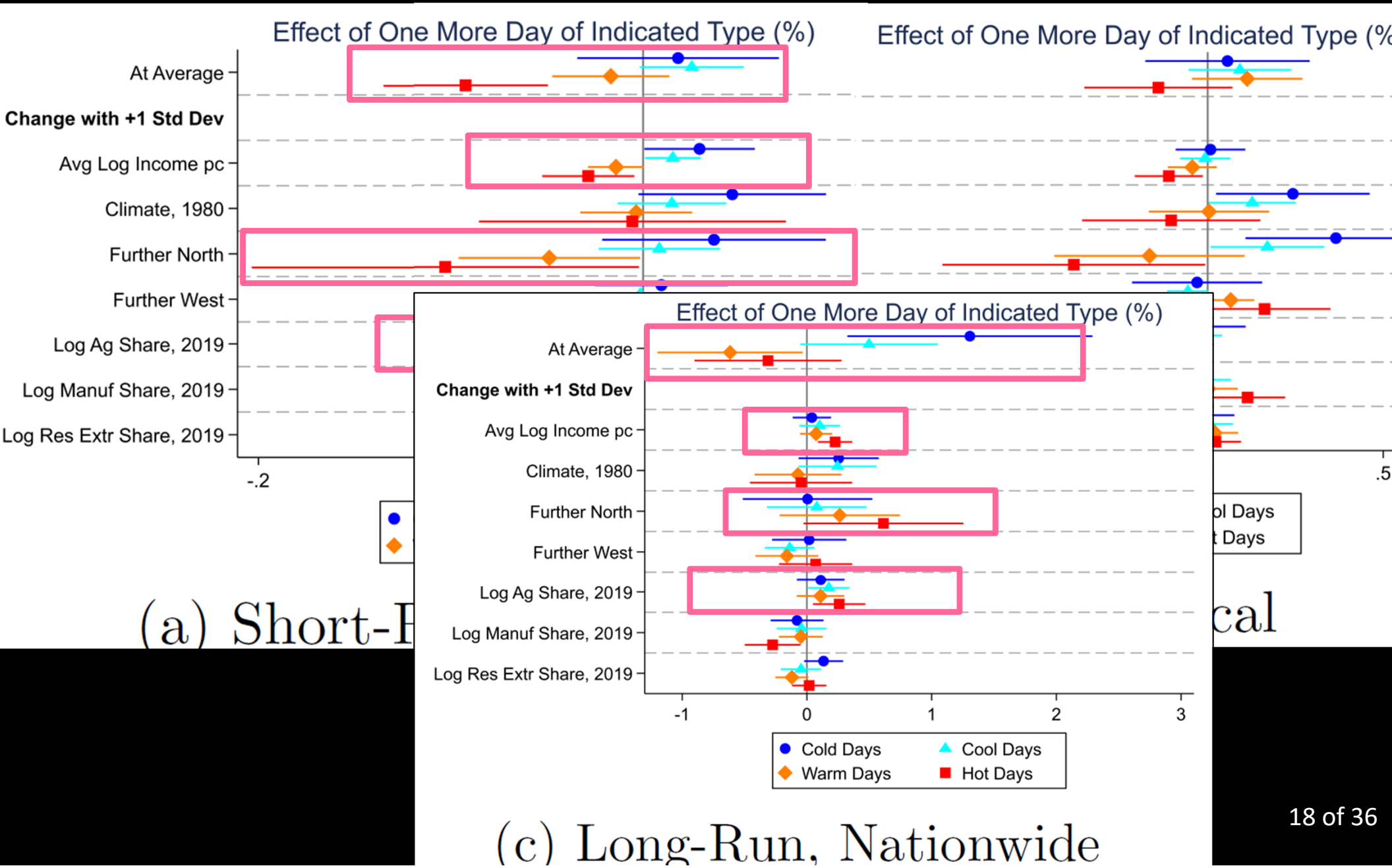
How estimate these costs?

1) Estimate effect of current/past, local/national weather on income

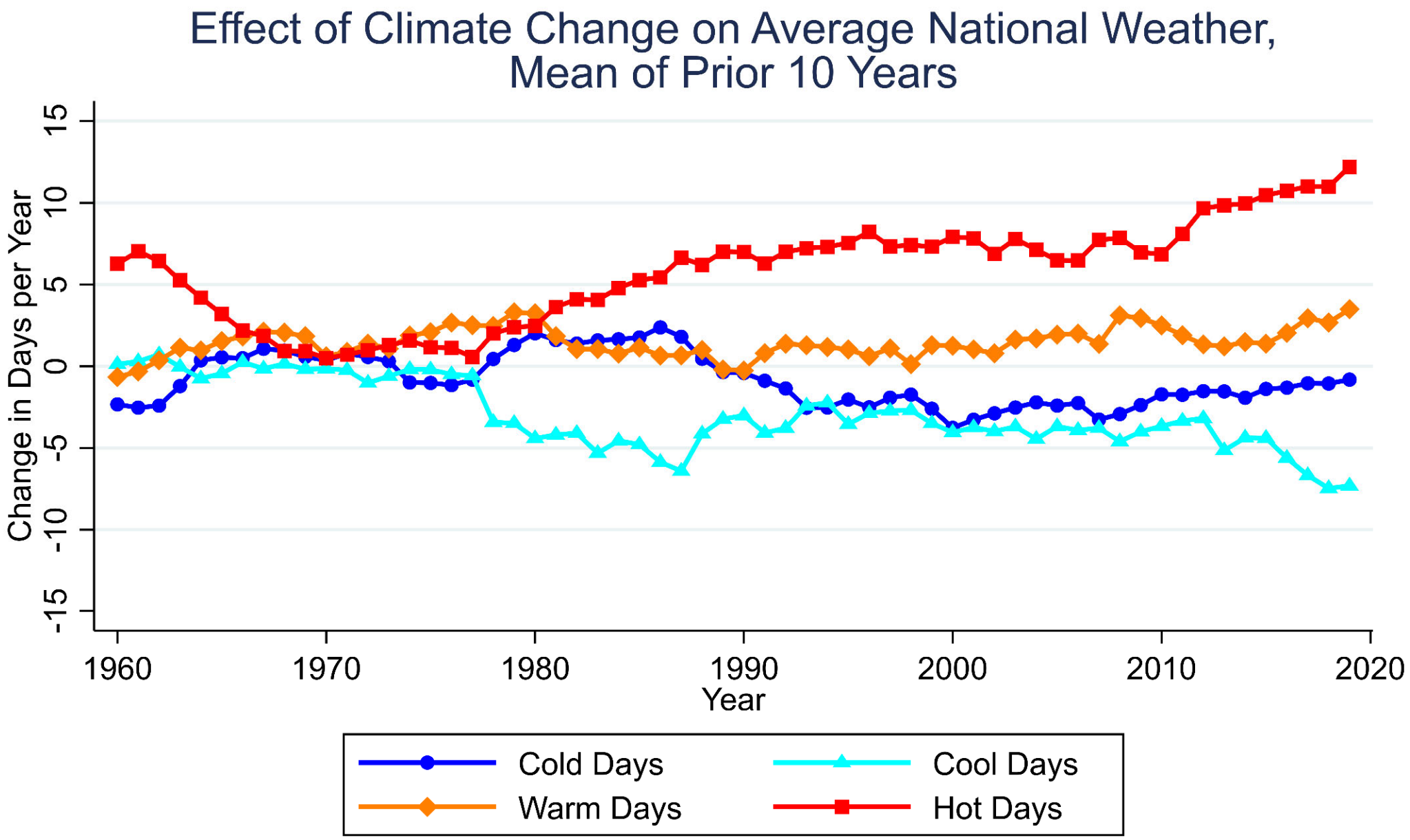
3) Calculate difference in income

2) Use climate models to determine weather without climate change

Results from (1): Hot days hurt income per capita on average, but there's a lot of variation.

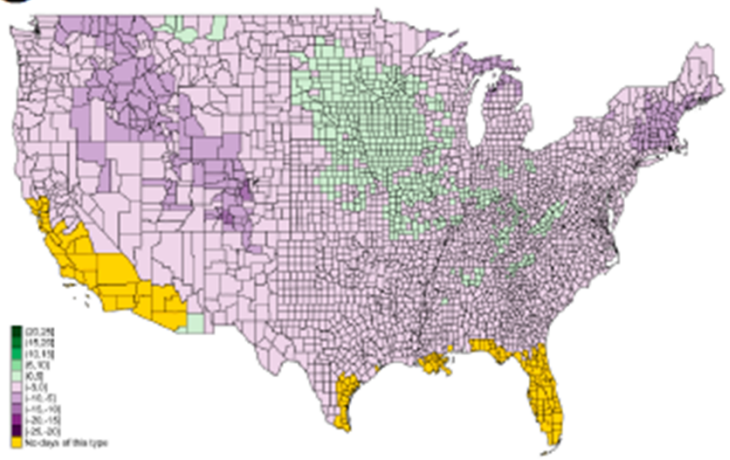


Results from (2): Climate change has increased hot/warm days and reduced cool/cold days



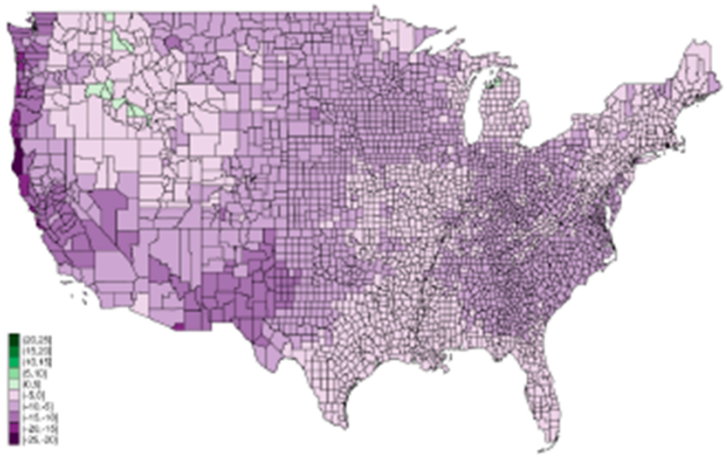
Climate affected weather differently in different places

C



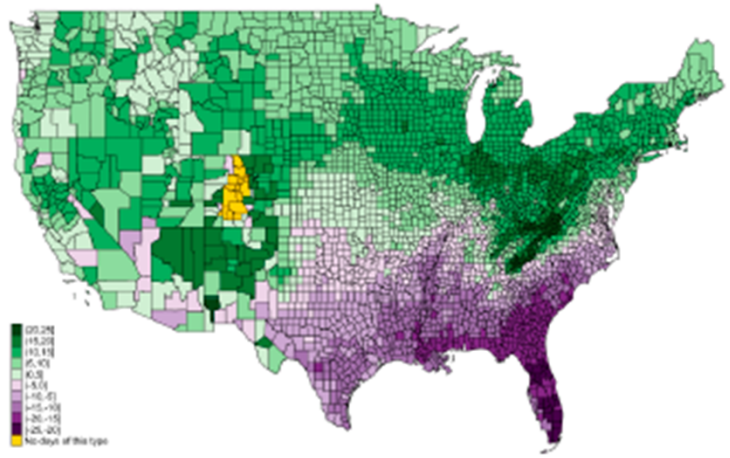
Effect of Climate Change on Cold Days

D



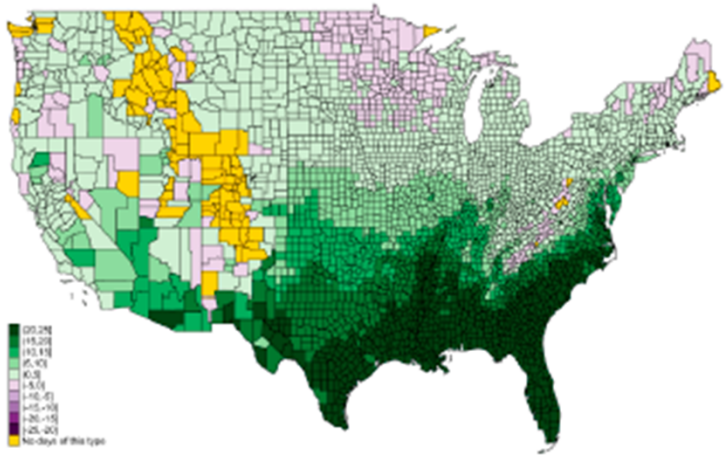
Effect of Climate Change on Cool Days

E



Effect of Climate Change on Warm Days

F



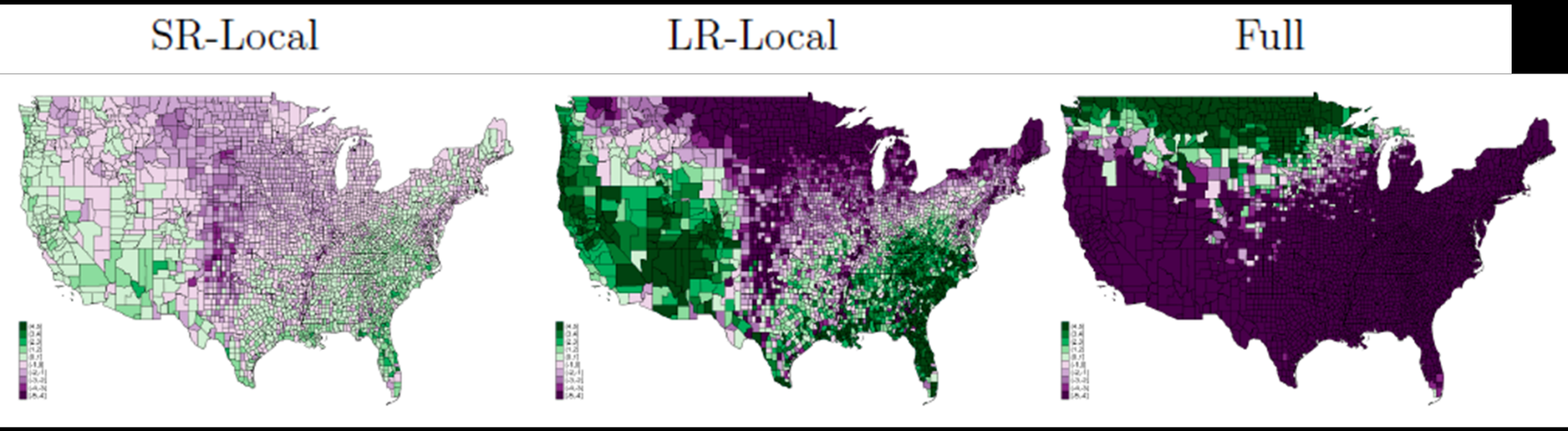
Effect of Climate Change on Hot Days

(3) Combine all to calculate impacts

Effects of weather on income per capita from step (1)

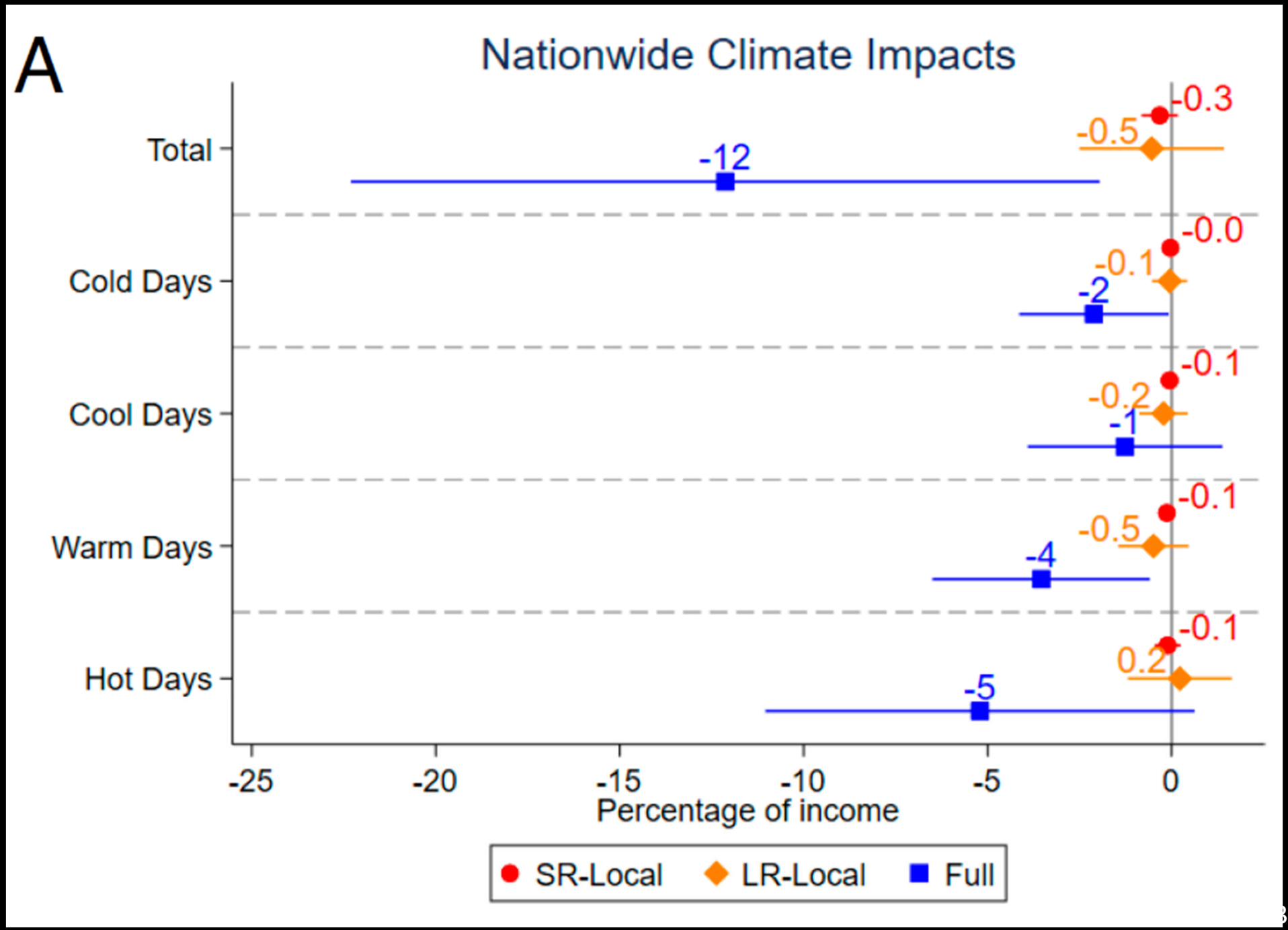
Effects of climate change on weather from step (2)

The scale and pattern of climate impacts is sensitive to the inclusion of national weather patterns (capturing prices and beliefs).

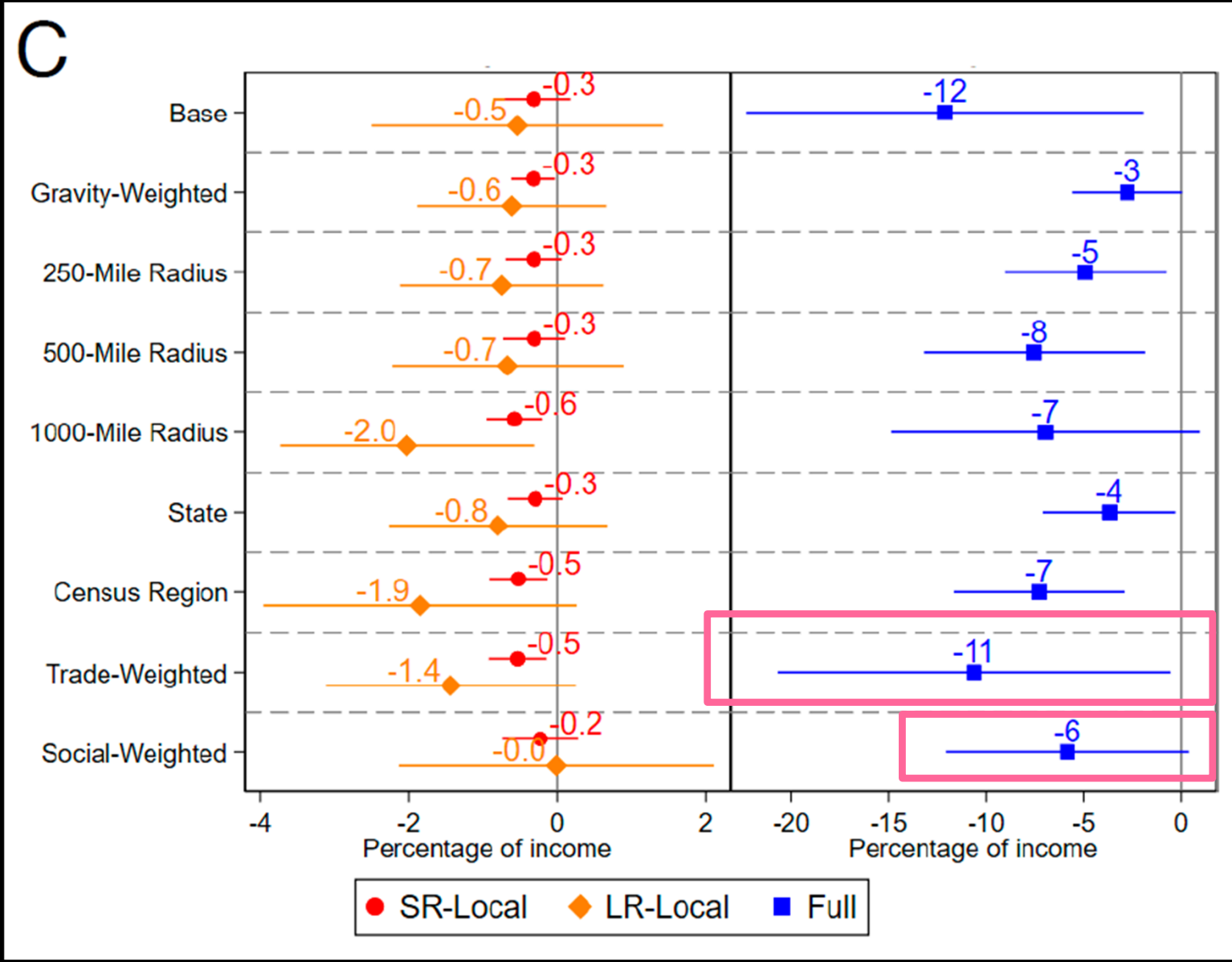


-> Critical to account for how climate changes weather patterns, not just local weather

Climate reduced US income over 2000-2019



Trade may be the channel through which national weather matters.



A new framework for estimating how climate has affected the economy in recent years

Annual losses may already reach 12% of national income

- Comparable to estimated impact of recently proposed trade/monetary/immigration policies
- Less salient because mostly through price channels?

Not a comprehensive accounting of climate consequences

- Sea level rise, Disasters, Precipitation, Mortality

Future work can update for new years' data, other countries' data, and industries' data

- Might institutionalize this updating, to be produced like other economic stats

5) Can use markets to project damages? (Lemoine 2024, *NBER WP*)

Typical way environmental economists think about pollution policy:

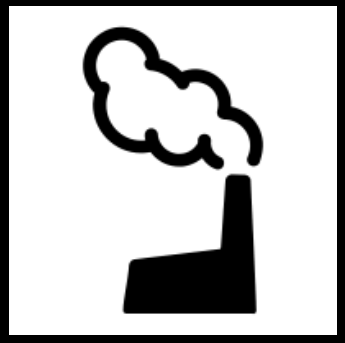
Academics/Agencies
Measure Social Cost

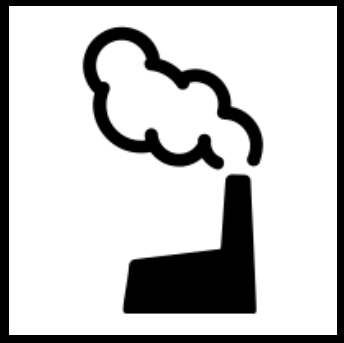
↓

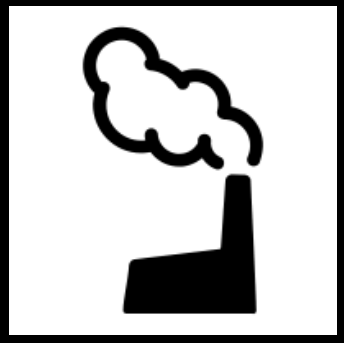
Regulator Implements Policy

↓

Firms Measure Their Own
Marginal Abatement Costs







We have centralized measurement of social costs among academics and regulators.

But every person and firm on this planet is exposed to climate change and has some information about that exposure.

Since at least Hayek (1945), a rich tradition views markets as an algorithm for aggregating dispersed information about costs and benefits.

What if markets could aggregate society's dispersed information about climate change impacts?

->Price discovery for externalities

I design a new type of policy that has three goals:

1) Efficiently price emissions, conditional on information

2) Efficiently incentivize removal of past emissions, conditional on information

3) Efficiently aggregate dispersed information about social costs

I show that an emission tax achieves only the first goal.

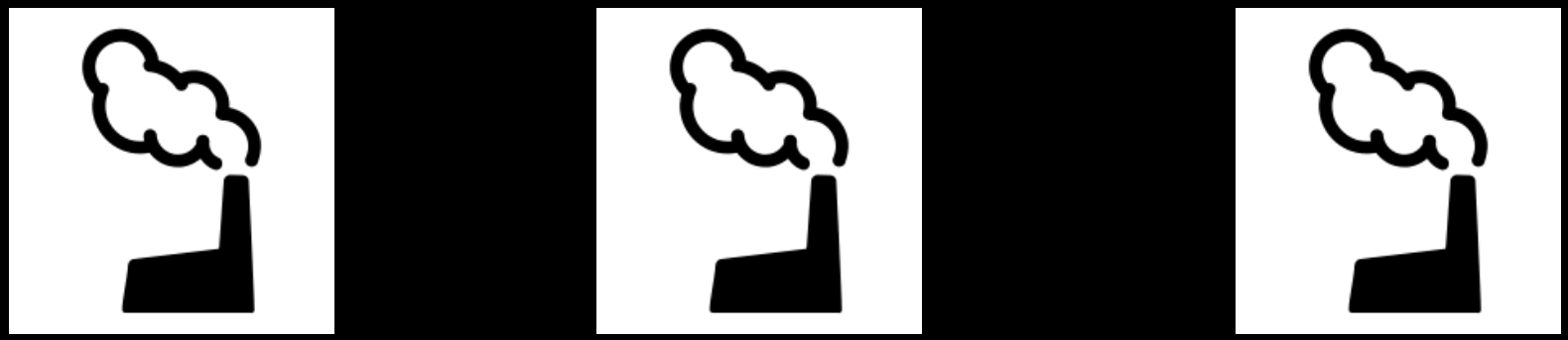
->Here one policy both measures and controls the externality.

Agents Measure Their Own Exposure to Climate Change

Regulator Measures Recent Aggregate Damages

Agents Trade Carbon Shares

Firms Observe Carbon Share's Price and Measure Their Own Marginal Abatement Costs



Carbon shares are transferable assets attached to each unit of carbon emitted

"Carbon share"
Value: q_t

Deposit
D

xferable

Incentive to reduce emissions:
$D - q_t$

(1) If time *t* carbon is still in the atmosphere at time *t+s*, the shareholder receives some money back (a "refund")

Damage charge Δ_{t+s}

Refund d_{t+s}

(2) If the shareholder removes the carbon from the atmosphere in time *t+s*, they receive the deposit and the share is retired.

Cost p_{t+s}^{R} of carbon removal

$(1 + \mathrm{r})\mathrm{D} - \Delta_{t+s}$

Example life of carbon share

	Time *t*	***t*+1**	***t*+2**	**…**	***t*+s**
Emitter:	Pays D, Receives share worth q_t	Sells share for q_{t+1}			
Shareholder:		Buys share for q_{t+1}, Receives d_{t+1}	Receives d_{t+2}		Pays p_{t+s}^R, Receives $(1+r)D - \Delta_{t+s}$

Carbon shares are a dynamic deposit-refund policy instrument

The refund varies annually based on whether realized damages were as bad as they could have been

Reducing emissions is valuable:

- Refunds are only partial, so good to not have to put down a deposit

Once carbon is emitted, shareholders choose whether to

- Bet on future refunds (i.e., on climate change being not too bad), or
- Recover whatever is left of deposit by paying to remove carbon

Market value of a share is market projection of future damage measurements

Conclusions

Economists have learned a lot about the direct effects of weather and a good bit about adaptation

But economists will never be able to project the full effects of climate change in the way we would like

- Unlike a day's weather, a change in climate is *anticipated, persistent, and widespread*

We can make more progress studying the costs of climate change to date

- May already be costing the US 12% of income, through trade channels

If we think beyond emission taxes and cap-and-trade, we can use markets to project future damages

- Institutionalize measurement of recent damages, like reporting on jobs