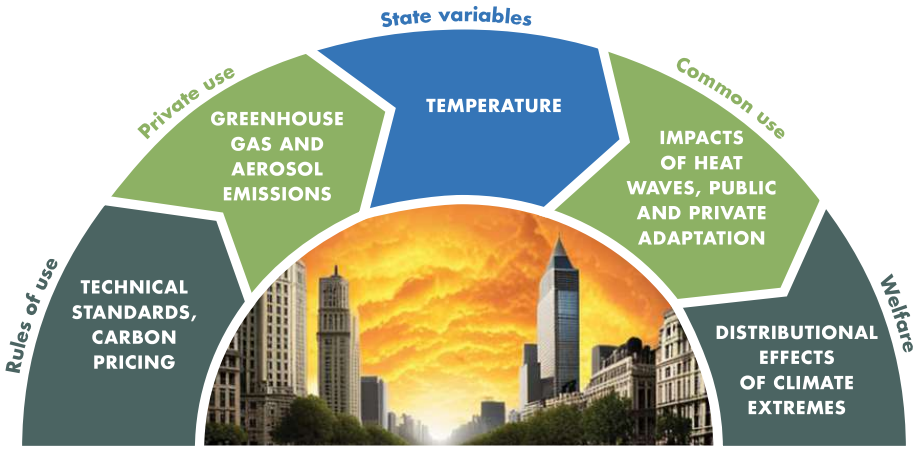
UNIVERSITÄT LEIPZIG

Regional climate

WHAT ARE THE DISTRIBUTIONAL EFFECTS OF ADAPTATION TO FUTURE "RECORD-SHATTERING" HEAT WAVES?

SEBASTIAN SIPPEL
CLIMATE MODELLING AND STATISTICS

THOMAS STEGER
ENVIRONMENTAL MACROECONOMICS



CLIMATE ATTRIBUTION

Sebastian Sippel, Thomas Steger

Understanding record-shattering heat waves

— Large ensemble model simulations and observations of daily temperatures
— Physical drivers of heat waves: Extreme circulation states, land-atmosphere feedbacks, climate change
— Attribution of events: Internal variability vs. forced response

Future heat waves and impacts

— How to estimate regional risk for record-shattering heat waves?
— What are the impacts of future heat waves in terms of mortality?
— How does private adaptation change impacts?

Second cohort: Attribute human mortality impacts of heat waves

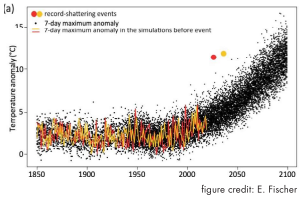
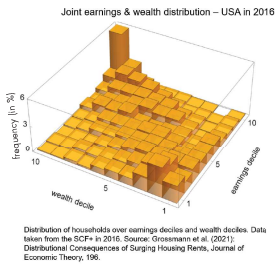


figure credit: E. Fischer

IMPACTS OF REGIONAL CLIMATE EXTREMES



Distribution of households over earnings deciles and wealth deciles. Data taken from the SCF+ in 2016. Source: Grossmann et al. (2021): Distributional Consequences of Surging Housing Rents, Journal of Economic Theory, 196.

ENVIRONMENTAL MACROECONOMICS

Thomas Steger, Sebastian Sippel

Climate-macroeconomic modelling

— Private adaptation decisions
— Simple climate-macro model under household heterogeneity
— Health damages (conditional on private adaptation)
— Regional heterogeneity

Regional and personal heterogeneity

— Employ regional temperature data
— Assume income distribution constant across regions
— Aggregate shocks → idiosyncratic consequences (Grossman et al., 2021, JET)

Second cohort: Study distributional effects with endogeneous health investments in an overlapping-generations model

SHARED METHODOLOGY:

Numeric dynamic modeling, optimitation and statistical analysis

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ICP REGIONAL CLIMATE

SEBASTIAN SIPPEL, THOMAS STEGER

ATTRIBUTION OF REGIONAL HEAT WAVES

RESEARCH QUESTIONS

— How can we understand "record-shattering" heat waves? Which drivers lead to these events, and can we attribute them?

— Can we identify factors or regions that lead to a possibility to anticipate such events?

— What are the implications of the occurrence (or non-occurrence) of those events for mortality-related welfare costs and adaptation activity in an economic model? (link to PhD Project 2)

STATE-OF-THE-ART

— Some recent heat extremes have shattered previous records by very large margins, such as the Pacific Northwest heatwave 2021 (Bartusek et al., 2022; Nat. Climate Change)

— Such events are also simulated in physical climate models, and usually imply a rare combination of internal variability in the historical record, and an exceptional event, where multiple extreme drivers combine (Fischer et al., 2021; Nat. Climate Change)

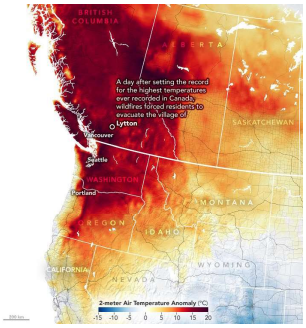
— Yet it remains unclear whether analyses of the historical record, combined with attribution storylines, could anticipate such events.

METHOD

— A framework of Climate Attribution, consisting of combining large model ensembles with observations, will be used to study these events:

— We aim to identify forced and unforced components in regional heat wave trends

— This will be used to test whether historical attribution of forced and unforced components can help to constrain the occurrence probabilities of record-shattering heat waves



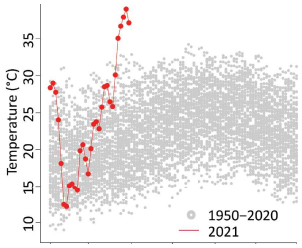


Figure Credit: E. Fischer, Pacific Northwest Heatwave 2021

DISTRIBUTION OF HEAT-RELATED MORTALITY COST

RESEARCH QUESTION

— How is the heat-related mortality cost distributed across poor and rich households within countries?

METHOD

— Climate-macro model (Ramsey) under household heterogeneity capturing heat-related mortality costs

— Households can protect against rising temperature through adaptation, depending on private resources

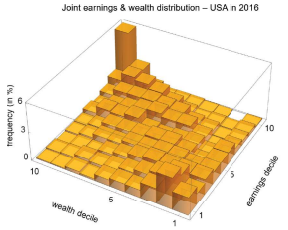
— National data disciplines the model: Representative agent economy replicates aggregate data

— Grossman et al. (JET, 2021): Aggregate shocks have idiosyncratic consequences (partial and generel equilibrium)

— Employ regional temperature data; first step: Assume earning / wealth distribution

$$\max_{\{C_t^i, A_t^i\}} \sum_{t=0}^{\infty} \beta^t \left[u(C_t^i) - \underbrace{h(T_t, A_t^i)}_{\text{heat-related mortality costs in terms of welfare}} \right]$$

$$\text{s.t.} \quad C_t^i + A_t^i + W_{t+1}^i = (1+r_t) W_t^i + w_t L_t^i$$



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EXPECTED RESULTS

— Quantification of individual welfare losses caused by heat waves (anthropogenic component) conditional on income and wealth

— Historical periods: More granular data on distribution of heat-related mortality costs

— Future: Alternative climate change scenarios

FOLLOW UP

— OLG model under temperature volatility. Survival depends on heat waves, age, health, adaptation

— Steps: Average temperature → heat extremes → health damages conditional on health / adaptation