Economics & Climate Change

Virginia Hernanz (University Alcalá)
virginia.Hernanz@uah.es

1st FutureMed Workshop & Training School
"A Transdisciplinary Network to Bridge Climate Science and Impacts on Society"
29 September – 3 October 2025 | Chania, Greece

FutureMed
TRANSDISCIPLINARY NETWORK

cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Climate Change: The Ultimate Challenge for Economics†

By William Nordhaus*

Figure 1. Climate Change as the Threatening Colossus

Source: Francisco de Goya, *El Coloso*, Museo Nacional del Prado

How can economics help us understand and respond to the challenges of climate change.

Economists don’t just study the costs and benefits of climate change. We also study the economic behavior of key economic agents (households and firms) to better understand how they respond to these changes and to design effective policies.

- At the micro level, economics studies how climate shocks affect household and producers’ behavior. Awarness, invidual patterns of migration etc.
- At the macro level, examines how climate change influences entire economies over time. We focuse on growth and long-term welfare, often using models and cross-country evidence.

Introduction

Climate shapes stakeholders' awareness, migration patterns, productivity and economic growth.

Economists analyze these effects with empirical strategies and economic models.

These methods **aim to identify causal relationships** and provide rigorous evidence for policy decisions.

This presentation uses economic research to assess climate change impacts and inform key policies

- Adaptation: how societies adjust to reduce damages from climate
- Mitigation: actions to reduce future climate risks, including cutting emissions and protecting ecosystems

Article	Data	Main Results	Econometric / Modeling Methods	Citations (APA style)
Awareness	Surveys, opinion polls, panel data, local weather/event exposure	Local climate events affect risk perceptions & policy support	Panel regressions, Natural experiments, Spatial regressions	Ayers, M., Marlon, J. R., Ballew, M. T., Maibach, E. W., Rosenthal, S. A., Roser-Renouf, C., & Leiserowitz, A. (2024). *Climatic Change, 177*(96). https://doi.org/10.1007/s10584-024-03754-x
Migration	Household panel surveys, census flows, remote sensing	Climate shocks influence migration patterns; spatial heterogeneity matters	Difference-in-differences, Instrumental variables, Spatial models	Barrios, S., Bertinelli, L., & Strobl, E. (2006). *Journal of Urban Economics, 60*(3), 357–371. https://doi.org/10.1016/j.jue.2006.04.005
Productivity	National & subnational GDP, worker/farm-level micro data, crop yields, gridded temperature	Heat and extreme weather reduce output; non-linear temperature effects	Panel regressions, Non-linear models, Spatial regressions	Burke, M., Hsiang, S. M., & Miguel, E. (2015). *Nature, 527*(7577), 235–239. https://doi.org/10.1038/nature15725
Growth & Emissions	National accounts, sectoral data, energy & emissions data	Climate policies and shocks affect GDP growth, sectoral output, and CO_2 emissions	Computable General Equilibrium (CGE) models, Integrated Assessment Models (IAM), Scenario analysis	Nordhaus, W. D. (2017). Revisiting the social cost of carbon. *Proceedings of the National Academy of Sciences, 114*(7), 1518–1523. https://doi.org/10.1073/pnas.1609244114

Migration and Climate Change

Climate shocks (droughts, floods, sea-level rise) influence migration.

Empirical approaches:

- Panel data: track households, firms (main agents) over time.
- Difference-in-Differences (DID): compare affected vs. unaffected regions before/after shock or new legislation

Climate Risk Management 39 (2023) 100472

Contents lists available at ScienceDirect

Climate Risk Management

journal homepage: www.elsevier.com/locate/crm

Migration and climate change – The role of social protection

Darya Silchenko [a,b], Una Murray [a,b,*]

[a] Migration, climate change and social protection project, Ryan Institute, National University of Ireland Galway, University Road, Galway H91 REW4, Ireland

[b] School of Geography and Archaeology, College of Arts, Social Sciences and Celtic Studies, National University of Ireland Galway, University Road, Galway H91 REW4, Ireland

A R T I C L E I N F O

Keywords:
Social protection
Climate vulnerability
Migration
Adaptation
Cash transfers
Public work program

A B S T R A C T

Social protection, as a vulnerability response tool, is well-placed to equip climate-vulnerable populations with resources that de-risk livelihoods and smooth consumption. This systematic literature review of 28 studies identifies evidence for how social protection has influenced beneficiaries' migration decisions, experiences, and outcomes in the context of a changing climate, through cash transfers, public work programs, insurance, and health care. The review reveal three key interlinkages between social protection policies and climate-migration, where social protection is recognized as a policy tool that can (i) ease the financial barriers to migration as a means of de-risking climate change impacts, (ii) address adverse drivers and structural factors that may compel people to engage in maladaptive, distress migration and (iii) support those 'left at home' in maintaining their livelihoods when they do not wish to leave. Understanding how social protection can be leveraged to stimulate positive climate-migration outcomes can aid policymakers, development practitioners, local governments, and social protection beneficiaries capitalize the necessary support in circumstances of migration or immobility in the context of adverse climate conditions. Knowledge gaps remain regarding the optimal methods in which social protection can support vulnerable groups and encourage positive outcomes of climate-migration. We expand the knowledge base by making a case for the inclusion of social protection in climate change and human migration debates; highlighting research and policy gaps and missed opportunities; and advocating for further empirical research on interlinkages and documentation of approaches where social protection can support voluntary, planned migration decisions where long-term adaptation is no longer viable.

Productivity Impacts

High temperatures and extreme weather reduce output.

- Micro studies: worker-level or firm-level data.
- Macro studies: GDP growth and long-term climate patterns.
- Methods:
  - Regression of output on temperature (micro). (First article)
  - Cross-country panel regressions (macro). (Second Article)
  - Structural models simulating future climate–growth scenarios.

Climatic Change (2020) 160:251–269
https://doi.org/10.1007/s10584-020-02661-1

A global analysis of heat-related labour productivity losses under climate change—implications for Germany's foreign trade

Nina Knittel[1] · Martin W. Jury[1] · Birgit Bednar-Friedl[1,2] · Gabriel Bachner[1] · Andrea K. Steiner[1,3]

Received: 25 September 2018 / Accepted: 16 January 2020 / Published online: 3 February 2020

Abstract
We investigate climate change impacts transferred via foreign trade to Germany, a country that is heavily engaged in international trade. Specifically, we look at temperature changes and the associated labour productivity losses at a global scale until 2050. We assess the effects on Germany's imports and exports by means of a global computable general equilibrium (CGE) model. To address uncertainty, we account for three Shared Socio-economic Pathways (SSP1, SSP2 and SSP3) and two Representative Concentration Pathways (RCP4.5 and RCP8.5) using projections from five global climate models. We find that average annual labour productivity for high intensity work declines by up to 31% for RCP4.5 (and up to 38% for RCP8.5) in Southeast Asia and the Middle East by 2050, all relative to a 2050 baseline without climate change. As a consequence, for RCP8.5, Germany's imports from regions outside Europe are lower by up to 2.46%, while imports from within Europe partly compensate this reduction. Also, Germany's exports to regions outside Europe are lower, but total exports increase by up to 0.16% due to higher exports to EU regions. Germany's GDP and welfare, however, are negatively affected with a loss of up to − 0.41% and − 0.46%, respectively. The results highlight that overall positive trade effects for Germany constitute a comparative improvement rather than an absolute gain with climate change.

Keywords Heat stress · Climate change · Labour productivity shocks · International trade · Computable general equilibrium · Germany

Effects of climate change on combined labour productivity and supply: an empirical, multi-model study

Shouro Dasgupta, Nicole van Maanen, Simon N Gosling, Franziska Piontek, Christian Otto, Carl-Friedrich Schleussner

Summary

Background Although effects on labour is one of the most tangible and attributable climate impact, our quantification of these effects is insufficient and based on weak methodologies. Partly, this gap is due to the inability to resolve different impact channels, such as changes in time allocation (labour supply) and slowdown of work (labour productivity). Explicitly resolving those in a multi-model inter-comparison framework can help to improve estimates of the effects of climate change on labour effectiveness.

Methods In this empirical, multi-model study, we used a large collection of micro-survey data aggregated to subnational regions across the world to estimate new, robust global and regional temperature and wet-bulb globe temperature exposure-response functions (ERFs) for labour supply. We then assessed the uncertainty in existing labour productivity response functions and derived an augmented mean function. Finally, we combined these two dimensions of labour into a single compound metric (effective labour effects). This combined measure allowed us to estimate the effect of future climate change on both the number of hours worked and on the productivity of workers during their working hours under 1·5°C, 2·0°C, and 3·0°C of global warming. We separately analysed low-exposure (indoors or outdoors in the shade) and high-exposure (outdoor in the sun) sectors.

Findings We found differentiated empirical regional and sectoral ERF's for labour supply. Current climate conditions already negatively affect labour effectiveness, particularly in tropical countries. Future climate change will reduce global total labour in the low-exposure sectors by 18 percentage points (range –48·8 to 5·3) under a scenario of 3·0°C warming (24·8 percentage points in the high-exposure sectors). The reductions will be 25·9 percentage points (–48·8 to 2·7) in Africa, 18·6 percentage points (–33·6 to 5·3) in Asia, and 10·4 percentage points (–35·0 to 2·6) in the Americas in the low-exposure sectors. These regional effects are projected to be substantially higher for labour outdoors in full sunlight compared with indoors (or outdoors in the shade) with the average reductions in total labour projected to be 32·8 percentage points (–66·3 to 1·6) in Africa, 25·0 percentage points (–66·3 to 7·0) in Asia, and 16·7 percentage points (–45·5 to 4·4) in the Americas.

Lancet Planet Health 2021; 5: e455–65

Centro Euro-Mediterraneo sui Cambiamenti Climatici, Venice Italy (S Dasgupta PhD); **Università Ca' Foscari Venezia, Venice, Italy** (S Dasgupta); **Climate Analytics, Berlin, Germany** (N van Maanen MSc, C-F Schleussner PhD); **Geography Department, Humboldt-Universität zu Berlin, Berlin, Germany** (N van Maanen, C-F Schluessner); **School of Geography, University of Nottingham, Nottingham, UK** (Prof S N Gosling PhD); **Potsdam Institute for Climate Impact Research, Potsdam, Germany** (F Piontek PhD, C Otto PhD); **Leibniz Association, Potsdam, Germany** (F Piontek, C Otto)

Correspondence to: Dr Shouro Dasgupta, Centro Euro-Mediterraneo sui Cambiamenti Climatici, Venice, Italy **shouro.dasgupta@cmcc.it**

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Future growth patterns of world regions – A GDP scenario approach

Marian Leimbach *, Elmar Kriegler, Niklas Roming, Jana Schwanitz

Potsdam Institute for Climate Impact Research, P.O. Box 60 12 03, D-14412 Potsdam, Germany

ARTICLE INFO

Article history:
Received 22 August 2013
Received in revised form 2 February 2015
Accepted 17 February 2015
Available online 31 March 2015

Keywords:
GDP scenario
Convergence
Economic growth

ABSTRACT

Global GDP projections for the 21st century are needed for the exploration of long-term global environmental problems, in particular climate change. Greenhouse gas emissions as well as climate change mitigation and adaption capacities strongly depend on growth of per capita income. However, long-term economic projections are highly uncertain. This paper provides five new long-term economic scenarios as part of the newly developed shared socio-economic pathways (SSPs) which represent a set of widely diverging narratives. A method of GDP scenario building is presented that is based on assumptions about technological progress, and human and physical capital formation as major drivers of long-term GDP per capita growth. The impact of these drivers differs significantly between different shared socio-economic pathways and is traced back to the underlying narratives and the associated population and education scenarios. In a highly fragmented world, technological and knowledge spillovers are low. Hence, the growth impact of technological progress and human capital is comparatively low, and per capita income diverges between world regions. These factors play a much larger role in globalization scenarios, leading to higher economic growth and stronger convergence between world regions. At the global average, per capita GDP is projected to grow annually in a range between 1.0% (SSP3) and 2.8% (SSP5) from 2010 to 2100. While this covers a large portion of variety in future global economic growth projections, plausible lower and higher growth projections may still be conceivable. The GDP projections are put into the context of historic patterns of economic growth (stylized facts), and their sensitivity to key assumptions is explored.

Growth and emissions

Nordhaus: Climate as an Economic Agent (Nobel prize conference)

Key Idea

Climate change acts as an economic actor influencing growth and welfare

DICE Model

Calculates the optimal carbon price to balance growth and climate risks

Policy Insight

Early mitigation is cost-effective

Climate decisions involve long-term economic trade-offs

Takeaway

Climate is not just environmental, it is economic agent

General Equilibrium / IAM (Nordhaus) and ABModel

- The economy is represented in aggregate using **representative agents** (households, firms, government).
- The model computes **optimal carbon prices, consumption, and investment over time**.

Agent-Based Model (ABM)

- Simulates **many heterogeneous agents** with individual behaviors.
- Emergent macro-level patterns arise from interactions of these agents.
- ABMs are usually **stochastic and bottom-up**, unlike the top-down DICE model

Methods and Empirical Toolbox

1. Difference-in-Differences (DID)

- **Compares changes over time between treated and control groups.**
- **Example: migration before/after drought in affected vs. unaffected regions.**

Floods and Adaptation Strategies: Evidence from Indian Manufacturing*
Marko Irisarri, Alejandro Rábano and José Nicolás Rosas
May 19, 2025
Abstract
We study how manufacturing establishments in India adapt to flood risk. Combining establishment-level data with geo-coded flood records and regional economic indicators, we examine how production and investment decisions respond to flood events conditional on historical exposure. We find that investment is more resilient in highrisk areas, consistent with forward-looking adaptation.

Our identification strategy exploits variation in the timing and intensity of exposure to severe and extreme floods across districts and over time. A popular method to estimate the causal effect of these types of “treatments” on an outcome is to compare over time groups experiencing different evolutions of their exposure to treatment, which is commonly referred to as the generalized differences-in-differences approach. This approach compares changes in outcomes across groups (districts) that experience differential exposure to treatment at different points in time.

In practice, this idea is implemented by estimating specifications of the form:

$$Y_{g,t} = \alpha_g + \lambda_t + \beta D_{g,t} + \varepsilon_{g,t},$$

where Y_{gt} denotes the outcome of interest for group g in period t, α_g are group (district) fixed effects, λ_t are time fixed effects, and **D_{gt} is a treatment indicator capturing exposure to a severe or extreme flood.** The coefficient β identifies the average effect of flood exposure, under the assumption of parallel trends.

2. **Instrumental Variables (IV)**
- Uses external variation (e.g., rainfall shocks) as instruments.
- Helps isolate causal effect of climate on migration/productivity.

3**. Panel Data with Fixed Effects**
- Tracks units (individuals, regions) over time.
- Controls for unobservable, time-invariant factors.

4. **Natural Experiments**
- Extreme events as exogenous shocks.

5. DICE and ABM: Climate as an economic agent

6. **New Tools**
- Machine learning, satellite data, big data integration.

Policy Implications

- Evidence-based policies require rigorous methods.
- Identifying vulnerable groups is key to adaptation.
- Guides investments in climate resilience.
- Provides foundations for migration and labor policies.
- Supports cost–benefit analysis of climate interventions.

Conclusion

- Climate change impacts awareness, migration, productivity and economic gowth
- Empirical methods (DID, IV, panel data, **DICE Model,** agent-based model (ABM)) provide causal insights.
- Research informs adaptation and mitigation strategies.
- Future: interdisciplinary work and new data sources.

Thank you very much for your attention