universität freiburg

Chair of Economic Theory,
especially Macroeconomics

Macroeconomic Perspectives on Climate Change

Workshop on May 23, 2025

9:00-9:05
Opening Remarks
Marten Hillebrand, University of Freiburg

9:10-10:00
Optimal Climate Policy with Demographic Transitions
Elisa Belfiori, Universidad Torcuato Di Tella

10:00-10:15 Coffee break

10:15-11:05
Three reasons to price carbon under uncertainty: Accuracy of simple rules
Christoph Hambel, Tilburg University

11:10-12:00
Optimal Climate Policy with Incomplete Markets
Albert Jan Hummel, University of Amsterdam

12:00-14:00
Conference Lunch at Haus zur Lieben Hand

14:00-14:50
Endogenous climate policy, systemic risk and asset stranding
Niko Jaakkola, University of Bologna

14:55-15:45
Structure, Shocks, and Speed: Learning's Impact on Optimal Climate Policy
Svenn Jensen, Oslo Metropolitan University

15:45-16:15 Coffee break

16:15-17:05
Temperature Shocks and Climate Change: A Conceptual Analysis
Christian P. Traeger, University of Oslo

17:10-18:00
Climate Change and International Risk Sharing
Markus Epp, University of Freiburg

19:00
Conference Dinner at Greiffenegg Schlössle

- Each talk should last about 35-40 minutes, followed by 10-15 minutes of discussion.
- All talks take place in **Rempartstrasse 16, room 02-012** (2nd floor).
- Office space is available in room 04-015 (4th floor).
- The **conference lunch** takes place at **Haus zur Lieben Hand**, Löwenstraße 16, 79098 Freiburg.
- The **conference dinner** takes place at **Greiffenegg Schlössle**, Schlossbergring 3, 79098 Freiburg.
- Generous financial support by the FWW is gratefully acknowledged.

macro.uni-freiburg.de

fww
FREIBURG.WIRTSCHAFT.WISSENSCHAFT.

Contributions

Optimal Climate Policy with Demographic Transitions

Authors: Elisa Belfiori, (Universidad Torcuato Di Tella), Manuel Macera (Universidad Torcuato Di Tella)

Abstract: This paper develops a framework to integrate demographic changes into climate policy analysis. We build an overlapping generations climate-economy model with a rich demographic structure, incorporating population growth and survival probabilities that shape the age composition of society. A central feature of our framework is an aggregation result: we show that demographic factors aggregate into social discounting. In particular, we show that the social discount rate decreases with population growth and increases as the age structure of the population shifts toward older individuals. We use this framework to study how current global demographic trends affect the social cost of carbon emissions – the model-based measure of the economic cost of climate change. Our findings reveal that demographics affect this cost through two key channels: scale and discounting. While a larger population increases output and associated climate damages (scale effect), population growth and aging increase the present cost of future damages by reducing the social discount rate. Quantitatively, we find that accounting for demographic transitions results in an optimal carbon tax substantially higher – up to 55% larger – than estimates from representativeagent economy that ignore population dynamics. However, despite the higher tax, the global temperature is also higher, indicating that current demographic trends will intensify the climate problem.

Three reasons to price carbon under uncertainty: Accuracy of simple rules

Authors: Ton van den Bremera (University of Amsterdam), **Christoph Hambel** (Tilburg University), Frederick van der Ploeg (University of Oxford)

Abstract: An easy-to-interpret rule for the optimal risk-adjusted social cost of carbon is derived using perturbation analysis. This rule internalises the adverse effects of global warming on the risk of recurring climate-related disasters and the risk of irreversible climate tipping points as well as the usual adverse effect on total factor productivity. It approximates the true numerical optimum well, especially if the small parameters (i.e., the share of damages in GDP, the sensitivity of the risk of disasters to temperature and the risk of climate tipping) are small enough and the discount rates corrected for growth and risk is not too small. The rule is also accurate if applied to models with a different supply side, e.g., with ongoing technical progress in fossil-fuel production or multiple economic sectors.

Optimal Climate Policy with Incomplete Markets

Authors: Thomas Douenne (University of Amsterdam), Sebastian Dyrda (University of Toronto), **Albert Jan Hummel** (University of Amsterdam), Marcelo Pedroni (University of Amsterdam)

Abstract: How do inequality, uninsurable income risk, and fiscal constraints shape the design of optimal climate policy? To address this question, we develop a climate-economy model with incomplete markets, where heterogeneous households face idiosyncratic risk. Within this framework, we analytically characterize the optimal carbon tax and show that it follows a modified Pigouvian formula, adjusted for inequality and fiscal distortions. We then calibrate the model to key features of the U.S. economy and solve numerically for the optimal path of carbon taxes, income taxes, and public debt over the transition. Our results indicate that concerns about inequality, risk, and fiscal distortions do not justify a less ambitious climate policy: deviations from the social cost of carbon remain minimal across a wide range of scenarios, even in the presence of strong fiscal constraints. Finally, we examine the implications of climate policy for redistribution, risk-sharing, and overall welfare.

Endogenous climate policy, systemic risk and asset stranding

Authors: Achim Hagen (Humboldt-Universität zu Berlin), **Niko Jaakkola** (University of Bologna), Angelika von Dulong (Aurora Energy Research)

Abstract: A regulator sets a carbon tax under stochastic climate change. Severe climate change demands high carbon taxes. The resulting downward pressure on fossil-related asset prices may precipitate a systemic financial crisis. We identify two equilibria: one is associated with carbon-intense investments and low carbon taxes, the other with a rapid fossil fuel phase-out and high taxes. A Pigovian tax on fossil investment takes into account the marginal systemic risk and yields a constrained efficient outcome. We also propose third-best instruments which eliminate the carbon-intense equilibrium: (1) increasing the equity buffer of the banking system; (2) increasing the wedge between the cost of funding fossil versus renewable assets; (3) separating fossil assets into a 'brown bank' network not connected to the rest of the financial sector. We argue that financial supervision cannot ignore climate concerns.

Structure, Shocks, and Speed: Learning's Impact on Optimal Climate Policy

Authors: Christian Traeger (University of Oslo), **Svenn Jensen** (Oslo MET)

Abstract: This study examines the impact of learning on optimal economic policy-making, with a focus on climate policy. Dynamic economic models with uncertainty depend on how agents anticipate and adapt to new information. We show that seemingly similar approaches to modeling learning can yield significantly different risk premiums in policy decisions. Our analysis focuses on the uncertain climate sensitivity, the temperature response to greenhouse gas accumulation. We distinguish two uncertainty components: natural temperature variability and subjective uncertainty about nature's true climate sensitivity. We provide an analytic formula for optimal carbon pricing under anticipated Bayesian learning. Whereas a decreasing variance over time reduces the risk premium, we show that learning's impact on the prior mean ("updating shocks") has an opposing effect. We explore these two different channels and different model variations in a stochastic dynamic programming version of Nordhaus' DICE model, exploring the trade-off between a "wait-and-see" argument and a more cautious approach.

Temperature Shocks and Climate Change: A Conceptual Analysis

Authors: Christian Traeger (University of Oslo)

Abstract: This paper addresses the challenge of accurately modeling and estimating climate change damages. Time-series approaches rely on weather shocks, while cross-sectional analyses capture climatic differences but suffer from omitted variable bias. Climate is defined as the statistical pattern of weather that persists over time and allows for adaptation, unlike unpredictable weather realizations. To assess econometric approaches, I (i) integrate forward-looking adaptation into a full-fledged integrated assessment model of climate change permitting an analytic solution and (ii) generalize the insights based on a novel dynamic envelope argument. I show how a carefully designed time series (or panel) estimation strategy can comprehensively identify the costs of climate change, including the indirect identification of unobserved adaptation costs. Unlike earlier approaches, this method does not rely on cross-sectional variation. The paper also presents the first explicit formula for the social cost of carbon under forward-looking adaptation. This result is not only insightful in its own right, but also valuable for clarifying and refining prevailing envelope theorem arguments in the literature.

Climate Change and International Risk Sharing

Authors: Markus Epp (University of Freiburg), Marten Hillebrand (University of Freiburg)

Abstract: The paper studies the strategic interaction of heterogeneous countries in a stochastic growth model of climate change. Each country is exposed to both fundamental and climate risk and chooses its domestic climate policy. Climate risk is determined endogenously and depends on the policies chosen by each country. We explore different market structures determining the scope for international trade and risk sharing between countries. Our main theoretical results provide analytical characterizations of optimal climate policies under full cooperation and non-cooperation between countries and show how these are shaped by the underlying market structure. We also explore the risk sharing properties of the induced decentralized allocations. Numerical simulations illustrate and quantify the theoretical results.