



Institute of Economics

Department of Economic Theory

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Syllabus for the Master's course

Macroeconomic Models of Climate Change

Winter semester 2025/26

- **Summary:**

The course provides a guided introduction to the theory and numerical simulation of macroeconomic models of climate change. Using state-of-the-art dynamic general equilibrium theory, each of the models to be discussed unifies an economic growth model with a model of the climate system. The growth model includes a description of the production process and its dependence on clean and dirty energy sources with the latter generating emissions of CO₂. The climate system describes how these emissions evolve in the atmosphere and feed back into the economic production process. The integrated modeling approach permits to incorporate the complete interactions between the climate system and the macroeconomy under alternative climate policies set by the government.

Based on this structure, the first part of the course focuses on global models of climate change as developed in Golosov et al. (2014). Their model incorporates various sources of clean and dirty energy and permits to derive a globally optimal climate policy in closed form.

Using the framework developed in Hillebrand & Hillebrand (2019, 2023), the second part extends these findings to a multi-region world permitting to incorporate regional heterogeneity and various clean and dirty energy sources. Assuming free trade between regions and a frictionless international capital market permits to determine an optimal climate tax policy and design a transfer scheme which redistributes tax revenue such that each region has an incentive to implement the optimal climate tax.

Using recent results from Hillebrand (2025), the final part of the course uses a game-theoretic approach to study optimal climate policies under different assumptions about cooperation and non-cooperation between regions and the formation of coalitions.

All models are first explored at the theoretical level and then simulated with Python using calibrated parameter values. Calibration draws on various data sources of key macroeconomic variables as well as energy and climate variables. The tutorials provide an introduction to programming in Python and help participants write their own simulation scripts in order to explore alternative climate policies and political scenarios.

- Contents (tentative):

1. The climate problem
2. Global models of climate change
3. Calibration and simulation of the global model
4. Multi-country models of climate change
5. Calibration and simulation of multi-country models
6. Climate policy under cooperation and non-cooperation

- Target audience:

Master students enrolled in the M.Sc. programs *Economics* and *VWL* and related fields such as Mathematics or Computer Science.

- Areas of study:

Economics and Politics (M.Sc. Economics)

Finance (M.Sc. Economics)

Information Systems and Network Economics (M.Sc. Economics)

Public Sector Economics (M.Sc. VWL)

International Taxation (M.Sc. VWL)

- Credit points: 6 ECTS

- Prerequisites:

Course participants should have attended at least one of the two courses *Advanced Macroeconomics 1* or *Advanced Macroeconomics 2*.

Above all, we expect a strong interest in the topic of climate change and in macroeconomic model building and programming in Python.

- Course meeting times:

Lectures take place on *Wednesdays, 10-12 am* in *R 01 012* (Rempartstrasse 16, 1st floor)

Tutorials take place on *Wednesdays, 4-6 pm* in *Max-Kade-Auditorium 1* (Alte Universität)

Lecture classes start on *Wednesday, October 15, 2025 at 10:15 am*

Tutorial classes start on *Wednesday, October 22, 2025 at 04:15 pm*.

- Organization:

The entire course material (slides, problem sets) is available on the ILIAS platform (ilias.uni-freiburg.de).

Students can directly sign up for the course and no password is required.

The course material will be released gradually every week. Participants enrolled in the course will be notified about all updates.

Same procedure applies for the tutorials.

- Teaching format:

All classes take place in-person requiring your presence in Freiburg.

Students unable to be in Freiburg can not participate in this course.

- Examination:

Course participants work on a (guided) extension of the models discussed in class on which they have to submit a write-up (about ten pages) and a Python simulation script.

All participants present and discuss their simulation results as part of a 'mini-conference' at the end of the semester.

- Literature:

- GOLOSOV, M., J. HASSLER, P. KRUSELL & A. TSYVINSKI (2014): "Optimal Taxes on Fossil Fuel in General Equilibrium", *Econometrica*, 82(1), 41–88.
- HILLEBRAND, E. & M. HILLEBRAND (2019): "Optimal Climate Policies in a Dynamic Multi-Country Equilibrium Model", *Journal of Economic Theory*, 179, 200–239.
- HILLEBRAND, E. & M. HILLEBRAND (2023): "Who Pays the Bill? Climate Change, Taxes, and Transfers in a Multi-Region Growth Model", *Journal of Economic Dynamics and Control*, 153.
- HILLEBRAND, M. (2025): "Win as a Team or Fail as Individuals: Cooperation and Non-Cooperation in the Climate Tax Game", SSRN Working paper, <https://doi.org/10.2139/ssrn.5149584>.

Additional references will be given in class.