

Climate macroeconomics and finance (B2120)

Also known as: Economics of Climate Change (75577)

University of Bologna
2024/25 Academic Year

Logistics

Lecturer: [Emanuele Campiglio](mailto:emanuele.campiglio@unibo.it) (emanuele.campiglio@unibo.it)

Teaching assistant: Hubert Massoni (hubert.massoni2@unibo.it)

Online presence: [Virtuale](#) (course material and submissions); [Panopto](#) (recordings)

Office hours: by appointment (please write email)

Course objective

The course will discuss the academic and policy research investigating the macro-financial implications of climate change and the low-carbon transition, as well as the appropriate societal responses to mitigate climate change. The course will consider qualitative, empirical, modelling and political economy methodological approaches. At the end of the course students will have developed a solid knowledge of the academic literature and policy debate on how climate change and the decarbonization process might affect economic activity, and vice versa. The course is the first module of the integrated course 'Climate and energy economics'. Information on the second module 'Climate policy and commodity markets', held by Niko Jaakkola, is available at [this link](#).

Course structure

The course is composed of ten lectures of three hours each (for a total of 30 hours), plus ten tutorial classes of two hours each (for a total of 20 hours). The course is roughly divided in two halves: (i) a first part introducing climate economic concepts and facts; (ii) a second part focusing on climate economic modelling. The overview of the course structure is the following:

1. Introduction + The big picture
2. Climate change: drivers, impacts, scenarios
3. Decarbonising the global economic system
4. Climate-related policies and commitments
5. Transition macro-finance: requirements, implications and policies
6. Modelling climate-economy interactions
7. The DICE model and its discontents
8. Integrated Assessment Models: big and small
9. Neoclassical climate macro models
10. Non-neoclassical climate macro models + Model coupling

Tutorial classes

Tutorial classes will be given by Hubert Massoni. Classes will include solutions to problem sets, in-depths dives on lecture topics, student-led discussion, guidance on essay writing and exam preparation. Tutorial classes are compulsory and its contents will be subject to evaluation during the exam.

Course readings

Most of the readings will be in the form of academic articles or policy reports. All readings will be available on Virtuale or through UniBo subscriptions. A key reading for the course is the set of recent reports (Assessment Report 6) by the Inter-governmental Panel on Climate Change (IPCC), available at [this link](#). While there is no specific textbook for this course, interested students can refer to:

- Economides, G., Papandreou, A., Sartzetakis, E. and Xepapadeas A. (2018) 'The economics of climate change', Bank of Greece (freely available at [this link](#))
- Tol, R. (2019) 'Climate Economics', 2nd edition, Edward Elgar Publishing (teaching material available at [this link](#))
- Keohane, N.O., and Olmstead, S.M. (2016) 'Markets and the Environment', 2nd edition, Island Press

Assessment

Students will be graded using a scale from 0 to 30, where grades lower than 18 means a fail. Particularly excellent work will be awarded a 'laude' (30L). The overall grade for the integrated course will be a simple average of the grades for the two modules. The grade for Module I (this course) will be the combination of:

- *Participation* (10%). This will be evaluated considering attendance and active participation to both lectures and tutorial classes.
- *Problem sets* (30%). Each student will submit eight problem sets during the course. Problem sets will be corrected during tutorial classes, and the deadline for submission is 23.59 of the day before the tutorial. Submission is individual, and will take place through Virtuale. Late submissions will not be accepted.
- *Group-work* (30%). Each student will self-allocate to a topic group (of roughly three members). Topics will be chosen among the ones provided by lecturer, but alternative topic proposals can be considered. Each group will: i) present the intermediate results of their work during tutorial classes in the second half of the course; ii) submit an essay by Wednesday 30 October at 23.59 via Virtuale. Group-work topic suggestions:
 1. The role of expectations/beliefs in shaping the low-carbon transition
 2. Climate policy uncertainty and investment decisions
 3. Firms production and adaptation to climate change
 4. The low-carbon transition in laboratory experiment evidence
 5. Finance for clean innovation: obstacles and policies
 6. The non-market impacts of climate change
 7. Production networks and carbon pricing
 8. The fairness of transition cost distribution
 9. Central bank communication on climate change
 10. The political economy of green central banking
- *Exam* (30%). A written exam for the module will take place on 7 November, 10.00am. The exam will include open essay-style questions, exercises and/or multiple choice questions. While this is strongly discouraged, students can decide to reject the grade obtained and try their luck with a 'full' exam, combining Module I and II. In this case, grades for Module I problem sets and groupwork will remain valid.

Course outline

17 September 2024 (Tuesday) 14:00-17:00

Aula V – Via Zamboni 33

Lecture 1. Introduction + The big picture

- Introduction to the course
- The big picture: a smooth and rapid low-carbon transition
- How can economics help?

18 September 2024 (Wednesday) 11:00-13:00

Aula I – Via Zamboni 38

Tutorial 1

- Introductions
- In-depth: Earth's climate system: the basic science

19 September 2024 (Thursday) 14:00-17:00

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Lecture 2. Climate change: drivers, impacts, scenarios

- Earth's climate system: the basic science
- The drivers of past and recent climate changes
- Climate socio-economic impacts
- Climate futures: SSP-RCP scenarios

Useful readings:

- IPCC Working Group I, 2021. The physical science basis. Summary for Policy-Makers. <https://www.ipcc.ch/report/ar6/wg1/>
- Hsiang, S., Kopp, R.E., 2018. An Economist's Guide to Climate Change Science. Journal of Economic Perspectives 32, 3–32. <https://doi.org/10.1257/jep.32.4.3>
- Carleton, T.A., Hsiang, S.M., 2016. Social and economic impacts of climate. Science 353, aad9837. <https://doi.org/10.1126/science.aad9837>

20 September 2024 (Friday) 09:00-11:00

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Tutorial 2

- In-depth: Climate mitigation technological options and their costs
- A primer on essay topics

24 September 2024 (Thursday) 14:00-17:00

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Lecture 3. Decarbonising the global economic system

- GHG emissions and their drivers
- The global carbon budget and emission pathways
- Emissions accounting: the Kaya identity
- Decarbonisation technological options
- Abatement costs

Useful readings:

- IPCC Working Group III, 2022. Mitigation of climate change. Summary for Policy-Makers. <https://www.ipcc.ch/report/ar6/wg3/>
- IEA. (2023). Net Zero by 2050—A Roadmap for the Global Energy Sector. International Energy Agency. <https://www.iea.org/reports/net-zero-by-2050>

25 September 2024 (Wednesday) 11:00-13:00

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Tutorial 3

- Solutions to Empirical problem set 1
- Methodology: Writing an essay
- In-depth: The Kaya framework

26 September 2024 (Thursday) 14:00-17:00

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Lecture 4. Climate-related policies and commitments

- Climate-related policy objectives: Paris agreement, NDCs, net-zero targets
- Environmental policy-making
- Market-based policies: carbon tax, ETS, subsidies (clean and fossil)
- Climate policy acceptability and uncertainty
- The EU Emission Trading Scheme

Useful readings:

- Carattini, S., Carvalho, M., & Fankhauser, S. (2018). Overcoming public resistance to carbon taxes. *WIREs Climate Change*, 9(5), e531. <https://doi.org/10.1002/wcc.531>
- Timilsina, G. R. (2022). Carbon Taxes. *Journal of Economic Literature*, 60(4), 1456-1502. <https://doi.org/10.1257/jel.20211560>
- World Bank. (2024). State and trends of carbon pricing 2024. The World Bank. <https://openknowledge.worldbank.org/entities/publication/b0d66765-299c-4fb8-921f-61f6bb979087>

27 September 2024 (Friday) 09:00-11:00

Aula Celio – Via Zamboni 38

Tutorial 4

- Solutions to Empirical problem set 2
- In-depth: Markets & policy tools

1 October 2024 (Tuesday) 14:00-17:00

Aula V – Via Zamboni 33

Lecture 5. Transition macro-finance: requirements, implications and policies

- Financing the low-carbon transition
- Climate-related macro-financial risks
- Asset stranding: reserves, capital, financial assets
- Sustainable finance policy-making

Useful readings:

- BNEF, 2024. Energy Transition Investment Trends 2024. BloombergNEF.
- Campiglio, E., & van der Ploeg, F. (2022). Macrofinancial Risks of the Transition to a Low-Carbon Economy. *Review of Environmental Economics and Policy*, 16(2), 173-195. <https://doi.org/10.1086/721016>

- Campiglio, E., Dafermos, Y., Monnin, P., Ryan-Collins, J., Schotten, G., & Tanaka, M. (2018). Climate change challenges for central banks and financial regulators. *Nature Climate Change*, 8(6), 462-468. <https://doi.org/10.1038/s41558-018-0175-0>
- Giglio, S., Kelly, B., & Stroebe, J. (2021). Climate Finance. *Annual Review of Financial Economics*, 13(1), 15-36. <https://doi.org/10.1146/annurev-financial-102620-103311>

2 October 2024 (Wednesday) 11:00-13:00

Aula I – Via Zamboni 38

Tutorial 5

- Solutions to Empirical problem set 3
- Students' presentations: essay motivation and research question

8 October 2024 (Tuesday) 14:00-17:00

Aula V – Via Zamboni 33

Lecture 6. Modelling climate-economy interactions

- Economic modelling building blocks: production and utility functions
- Introducing climate: emissions, abatement, damages
- Discounting
- Damage functions
- The Social Cost of Carbon

Useful readings:

- Groom, B., Drupp, M. A., Freeman, M. C., & Nesje, F. (2022). The Future, Now : A Review of Social Discounting. *Annual Review of Resource Economics*, 14(1), 467-491. <https://doi.org/10.1146/annurev-resource-111920-020721>
- Carleton, T., & Greenstone, M. (2022). A Guide to Updating the US Government's Social Cost of Carbon. *Review of Environmental Economics and Policy*, 16(2), 196-218. <https://doi.org/10.1086/720988>

09 October 2024 (Wednesday) 11:00-13:00

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Tutorial 6

- Solutions to Empirical problem set 4
- Students' presentations: essay motivation and research question

10 October 2024 (Thursday) 14:00-17:00

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Lecture 7. The DICE model and its discontents

- The DICE model structure and equations
- Main results from the DICE model
- Critiques and improvements on DICE

Useful readings:

- Barrage, L., & Nordhaus, W. D. (2023). Policies, Projections, and the Social Cost of Carbon : Results from the DICE-2023 Model (w31112). National Bureau of Economic Research. <https://doi.org/10.3386/w31112>
- Nordhaus, W. (2019). Climate Change : The Ultimate Challenge for Economics. *American Economic Review*, 109(6), 1991-2014. <https://doi.org/10.1257/aer.109.6.1991>

- Hänsel, M. C., Drupp, M. A., Johansson, D. J., Nesje, F., Azar, C., Freeman, M. C., Groom, B., & Sterner, T. (2020). Climate economics support for the UN climate targets. *Nature Climate Change*, 10(8), 781-789. <https://doi.org/10.1038/s41558-020-0833-x>

11 October 2024 (Friday) 09:00-11:00

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Tutorial 7

- Solutions to Empirical problem set 5
- In-depth: The building blocks of economic analysis

15 October 2024 (Tuesday) 14:00-17:00

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Lecture 8. Integrated assessment models big and small

- Analytical IAMs
- Numerical IAMs
- CGE models

Useful readings:

- Golosov, M., Hassler, J., Krusell, P., Tsyvinski, A., 2014. Optimal Taxes on Fossil Fuel in General Equilibrium. *Econometrica* 82, 41–88. <https://doi.org/10.3982/ECTA10217>
- Dietz, S., van der Ploeg, F., Rezai, A., Venmans, F., 2021. Are Economists Getting Climate Dynamics Right and Does It Matter? *Journal of the Association of Environmental and Resource Economists* 8, 895–921. <https://doi.org/10.1086/713977>
- Campiglio, E., Dietz, S., Venmans, F., 2022. Optimal Climate Policy As If the Transition Matters (CESifo Working Paper No. 10139). CESifo, Munich. Available at: <https://www.cesifo.org/en/publications/2022/working-paper/optimal-climate-policy-if-transition-matters>
- Rogelj, J. et al. 2018. Scenarios towards limiting global mean temperature increase below 1.5 °C. *Nature Clim Change* 8, 325–332. <https://doi.org/10.1038/s41558-018-0091-3>
- IAM Consortium (IAMC) Wiki, available at <https://www.iamcdocumentation.eu/>
- Desmet, K., Rossi-Hansberg, E., 2024. Climate Change Economics over Time and Space. *Annual Review of Economics* 16, 271–304. <https://doi.org/10.1146/annurev-economics-072123-044449>

16 October 2024 (Wednesday) 11:00-13:00

Aula I – Via Zamboni 38

Tutorial 8

- Solutions to Modelling problem set 1
- In-depth: The DICE model

17 October 2024 (Thursday) 14:00-17:00

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Lecture 9. Neoclassical climate macro models

- Overview of macro modelling approaches
- E-DSGE models
- Asset pricing models

Useful readings:

- Annicchiarico, B., Carattini, S., Fischer, C., & Heutel, G. (2022). Business Cycles and Environmental Policy: A Primer. *Environmental and Energy Policy and the Economy*, 3, 221-253. <https://doi.org/10.1086/717222>
- Carattini, S., Heutel, G., Melkadze, G., 2023. Climate policy, financial frictions, and transition risk. *Review of Economic Dynamics*. <https://doi.org/10.1016/j.red.2023.08.003>

- Hambel, C., Kraft, H., van der Ploeg, F., 2024. Asset Diversification Versus Climate Action. *International Economic Review* 65, 1323–1355. <https://doi.org/10.1111/iere.12691>

18 October 2024 (Friday) 09:00-11:00

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Tutorial 9

- Solutions to Modelling problem set 2
- In-depth: Adaptation vs. mitigation (mock exam discussion)
- In-depth: Intra-country inequalities, socio-economics of mitigating climate change (mock exam discussion)

22 October (Tuesday) 14:00-17:00

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Lecture 10. Non-neoclassical climate macro models + Model coupling

- Stock-flow consistent models (SFC)
- Agent-based models (ABMs)
- Behavioural macro models
- Hybrid models and the NGFS scenarios

Useful readings:

- D'Alessandro, S., Cieplinski, A., Distefano, T., Dittmer, K., 2020. Feasible alternatives to green growth. *Nature Sustainability* 3, 329–335. <https://doi.org/10.1038/s41893-020-0484-y>
- Castro, J., Drews, S., Exadaktylos, F., Foramitti, J., Klein, F., Konc, T., Savin, I., & Bergh, J. van den. (2020). A review of agent-based modeling of climate-energy policy. *WIREs Climate Change*, 11(4), e647. <https://doi.org/10.1002/wcc.647>
- Lamperti, F., Bosetti, V., Roventini, A., Tavoni, M., 2019. The public costs of climate-induced financial instability. *Nat. Clim. Chang.* 9, 829–833. <https://doi.org/10.1038/s41558-019-0607-5>
- Campiglio, E., Lamperti, F., Terranova, R., 2024. Believe me when I say green! Heterogeneous expectations and climate policy uncertainty. *Journal of Economic Dynamics and Control* 165, 104900. <https://doi.org/10.1016/j.jedc.2024.104900>
- NGFS, 2023. NGFS Climate Scenarios Technical Documentation v4.2. Available at: <https://www.ngfs.net/en/ngfs-climate-scenarios-phase-iv-november-2023>

23 October 2024 (Wednesday) 11:00-13:00

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Tutorial 10

- Solutions to Modelling problem set 3
- Exam preparation session

A non-comprehensive list of relevant data sources

- [IPCC WGI Atlas](#) (climate change, past and future)
- [Climate Change Tracker](#) (climate change, emissions)
- [IMF Climate Change Dashboard](#) (climate change, emissions, policies, finance)
- [Climate Impact Map](#) (climate impacts, past and future)
- [Climate Watch](#) (emissions, country commitments)
- [Climate Action Tracker](#) (emissions, commitments)
- [Climate TRACE](#) (geospatial, emission sources)
- [Global Carbon Atlas](#) (emissions)
- [ND-GAIN Index](#) (country vulnerability, readiness)
- [Environmental Performance Index](#) (country environmental variables)
- [EM-DAT](#) (disasters)
- [Global Registry of Fossil Fuels](#) (emissions, fossil reserves and production)
- [Global Power Plant Database](#) (geospatial, power plants)
- [AR6 scenario explorer](#) (IPPC AR6 models and scenarios)
- [International Energy Agency](#) (data galore: energy, policies, emissions, investment, and more)
- [ICAP](#) (carbon markets)
- [WB carbon pricing dashboard](#) (carbon pricing initiatives)