



EUROPEAN CENTRAL BANK

EUROSYSTEM

Warming the MATRIX: paper discussion

Conference Macroeconomic
modelling frontiers for
research and policy

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What the paper is about (1/2)

Warming the **MATRIX**: Uncertainty and heterogeneity in climate change impacts and policy targets in the Euro Area

- Economic effects of climate change and mitigation policies in EA
- Focus on uncertainties and heterogeneous impacts in climate and economic systems
- Extends the MATRIX model by integrating climate dynamics and policy interventions



Motivation

- Improve **modelling framework**
- Offer more **nuanced and realistic** assessment of economic impacts
- Improve **climate policy design** to account for regional differences



Research question

How do **uncertainty and heterogeneity** in climate and economic systems influence the economic impacts of climate change and the feasibility of mitigation targets in the Euro Area?

What the paper is about (2/2)

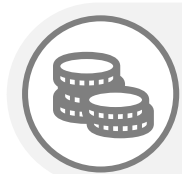
Agent-based integrated assessment framework to simulate **climate scenarios**

MATRIX = agent-based stock-flow consistent macroeconomic model, focused on energy production and consumption

- Heterogeneous agents
- Climate, Banks, Central Bank, Households, Firms and Governments
 - Firms contribute to climate change via CO₂
 - Different models to represent future climate evolution (robustness)
 - Different climate damage functions (homogeneous and heterogeneous)
 - Governments settle carbon tax to comply with broad climate objectives. Firms lower emissions (abatement costs)

What the paper is about (2/2)

Heterogeneous climate damages **amplify magnitude and volatility** of GDP losses from climate change



Economic impacts of climate change

- Homogeneous shocks may underestimate climate change effects on aggregate output by up to 33% (by 2100)



Role of policy and technological progress

- High emission reduction requires high carbon taxes (EUR 110 – EUR210/tCO₂ for 75% emission reduction).
- Technological advancements necessary to reduce abatement costs, thus emissions



Behavioral dynamics

- Heterogeneous climate shocks amplify coordination failures, which in turn cause more severe economic disruptions. Policy inertia also contributes to nonlinear effects

Key strengths of the paper (1/2)

Paper extremely relevant in current **policy and political debate**



Advance existing literature

- Combines advantages of IAMs and pure agent-based models in terms of heterogeneity and complexity of the simulated framework
- Enhanced applicability of modelling framework



Support current debate

- Robust, evidence-based call for action
- Insights for policymakers, especially in the context of “Fit-for-55 package”
- Socio-economic dimension of climate change and climate policies (climate justice)

Key strengths of the paper (2/2)

Paper advance existing literature via **modelling improvements** and **original policy reflections**

Modelling improvements



- Combination of agent-based approach and broad macroeconomic modelling of many sectors
- Dynamic adjustments via testing different policy tools

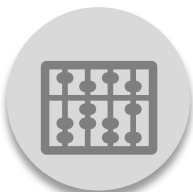
Policy reflections



- How climate change and climate policies are shaped by climate uncertainty and different agent responses
- More accurate calibration of policy interventions, to account for **sectoral** and **geographical differences**

Caveats of the paper

Model complexity is a strength as well as a limitation



- Many parameters are **exogenous** and based on **existing literature**. Especially on technological advancement, this could limit credibility of results



- Combination of many different factors produces **big uncertainty** on results: good to identify overall direction of travel, rather than precise estimations



- **Structural change of the economy** needed for the green transition is not considered in the paper: this may structurally change the relationship between firms' business models, households' consumptions and governments expenditure

Possible refinements and policy applications

The model could help answering **targeted policy questions**, particularly relevant in current policy debate and geopolitical context

Technical refinements

- **Non-linear damage functions** and feedback loops (tipping points) to explore extreme outcomes
- **International** spillover effects and cross-border economic feedbacks

Possible model extensions

- Implications of **asymmetric implementation** of climate policies in EU (on climate targets and damages)
- Implications of **decreased climate ambition in EU**
- Implications of **geopolitical uncertainty** (via supply chain and trade disruptions)

A few open questions

- **Role of carbon tax:** is it equivalent to the social cost of carbon (as in IAMs)?
- Is there a role for **actors' expectations** around climate policies and/or climate damages?
- How can you combine EA-specific models (and regulations) with **global climate targets/temperature**?
- How the effects of **different energy technologies** could be included?
- How would you compare this model (and results) with **different scenario** set-up (i.e. IEA and NGFS scenarios)?
- Do you consider **country-specific climate policies** (as opposed to EA-level ones)?