EUROPEAN CENTRAL BANK

EUROSYSTEM

[Please select]

Warming the MATRIX: paper discussion

Conference Macroeconomic modelling frontiers for research and policy

28/11/2024

L. Parisi

DG International and European relations

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