Economic Modelling for Assessing Climate Policies

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Climate economic models

Climate policy analysis often uses **Computable General Equilibrium Models (CGE),** characterized by:

- Introduce climate policy as additional constraint → less optimal outcomes → discussions focus on economic costs
- Optimal use of capital: investment stimulus is crowding-out other investment or consumption
- Labour market equilibrium: market-clearing excludes possibility of (present) involuntary unemployment
- No coordination problems: Representative agent and complete information assumes away coordination problems
- Complete financial markets: banks are only intermediary, agents are perfectly creditworthy and carry no default risk, money as unit of account, not a store of value.

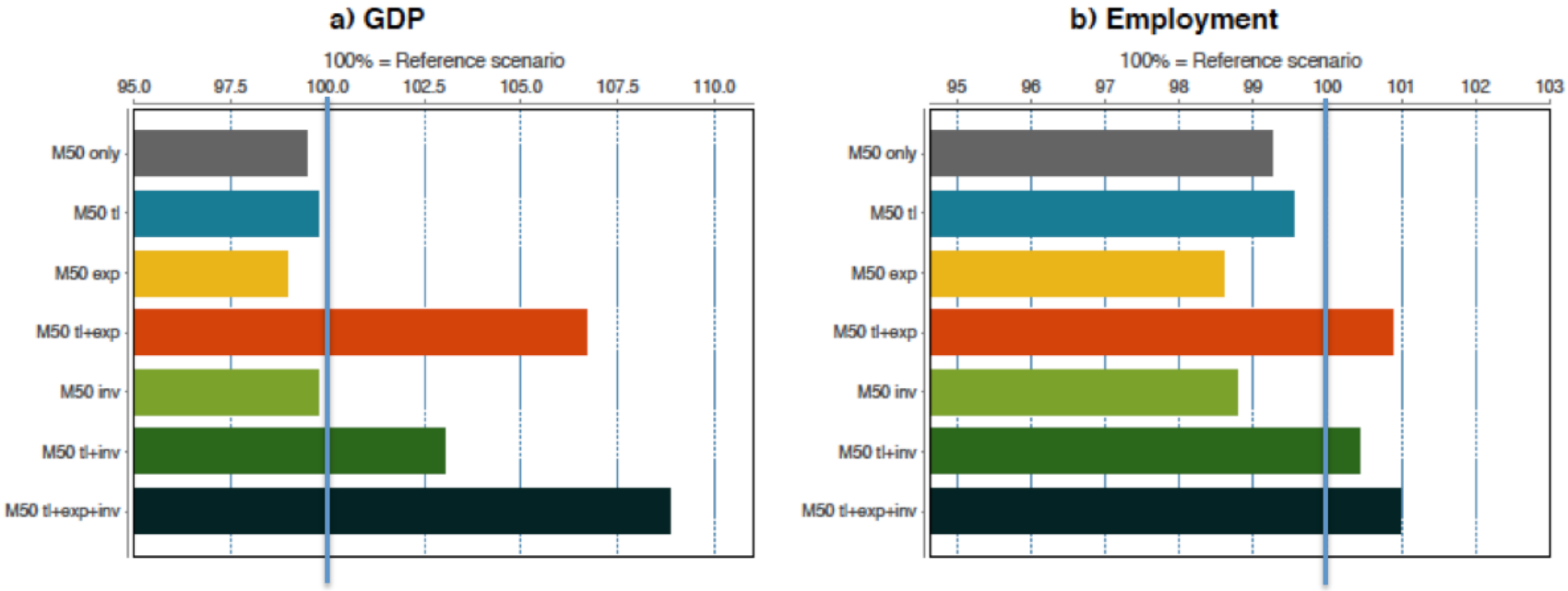
The possibility of "green growth" is excluded by design.

Key mechanisms for multiple equilibria

- **Possibilities of the model to account for expectations**
- **Endogenous technical progress / directed technical change**

Implementation in GEM-E3

- EU emission target: 50% reduction until 2030.
- Model changes: learning-by-doing, adaptive expectations and investment program.



Franziska Schütze, Steffen Fürst, Jahel Mielke, Gesine A Steudle, Sarah Wolf, and Carlo Jaeger, "The role of sustainable investment in climate policy", Sustainability 9, 2221 (2017).

Implementation in GEM-E3

Single model changes are in line with the literature:

- Learning-by-doing partially offsets the neg. effect of emission constraints;
- Increased investments lead to crowding-out

Combined model changes offer new insights:

- Learning-by-doing opens possibility for different growth paths
- Investment impulse with adaptive expectations can push the system to a different growth path and lead to positive economic effects

Climate policies: need to be combined with economic policies that increase investment levels and foster learning-by-doing.

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A model for green growth

A standard growth model (intertemporal utility optimisation of agents, neoclassical production function)

+ learning-by-doing (e.g. Nagy et al. 2010): labour productivity increases with capital accumulation (decentralised equilibrium suboptimal)

+ labour market with search externality (à la R. Farmer, e.g. 2009): search labour necessary for productive labour, and a continuum of labour market equilibria

+ directed technical change (e.g. Acemoglu et al. 2012, Rozenberg et al. 2013) with "brown" and "green" activities

Gesine A Steudle, Sarah Wolf, Jahel Mielke, and Carlo Jaeger,
"Green growth mechanics: The building blocks",
GCF Working Paper 1/2018.

A model for green growth

With these three buildings blocks we can construct an investment game with

- two investors that can choose between
- two possible investment strategies (green/brown)

→ The result is a structure with two Nash equilibria, one is Pareto-superior (green/green) and the other is less risky for the individual investor (brown/brown)

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Climate change mitigation – a *Prisoner's Dilemma*?

Climate mitigation issues (climate negotiations, carbon bubble discussion, etc.) are usually framed as:

"Costly efforts today prevent damages due to global warming tomorrow - if enough actors participate."

Prisoner's dilemma:

		prisoner 2	
		remain silent	give evidence
prisoner 1	remain silent	2 / 2	0 / 3
	give evidence	3 / 0	1 / 1

- Main problem: free riders
- Possible solutions: internalisation of the externality via taxes, (enforcable) treaties, …

Climate change mitigation – a *Stag Hunt*?

The green-growth model suggests a different game-theoretic analogy.

Stag hunt:

		hunter 2	
		hunt stag	hunt hare
hunter 1	hunt stag	3 / 3	0 / 2
	hunt hare	2 / 0	2 / 2

Lab experiments: Players often fail to coordinate on the "stag-equilibrium" due to risk averseness / a lack of trust.

- Main problem: a successful coordination on the payoff-dominant equilibrium depends on the expectations of the players
- Policy implication: coordination of expectations through coherent and credible climate policy signals

Jahel Mielke and Gesine A Steudle,
"Green investment and coordination failure – an investors' perspective".
(under review at Ecological Economics)