

Structural change and socio-economic disparities in a net zero transition

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AgroParisTech-CIRED / University of Exeter / E3Modelling

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Introduction

- A global transition to net zero CO₂ emissions is required to meet Paris Agreement climate goal (well-below 2C)
- Existing studies on global economic impacts of mitigation (AR6, IPCC, WGIII) :
 - 2-3% global GDP loss compared to baseline in 2050 to meet 1.5C target
 - Regional variations (1 - 7% GDP loss in 2050) : carbon intensive and energy-exporting countries bear the highest economic costs
- Most studies are based on cost-optimal/optimal-growth IAM and CGE models with no or limited market imperfections
- Limited number of studies exploring structural change/sectoral effects (output, employment) in global deep mitigation scenarios : old high-carbon industries and related supply chains expected to decline while new low-carbon industries and occupations will be created

Research questions :

- What macroeconomic and sectoral economic impacts in the global and regional economies induced by a transition to net zero ?
- Exploring uncertainties in economic assessment linked to : i) macroeconomic theory, ii) techno-economic flexibility (technical change and labour market flexibility) (and iii) functioning of global energy markets)

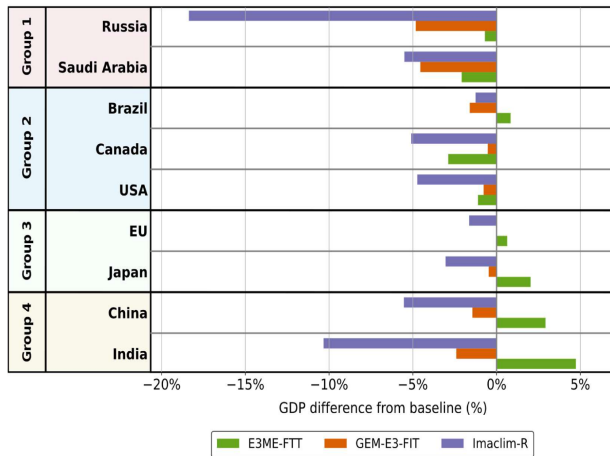
Study design : Model intercomparison study based on three multi-sectoral and multi-regional macroeconomic IAMs - Two scenarios :

- A baseline scenario based on Current Policies without intensification in the future
- A Global Net Zero scenario compliant with a 600-700 GtCO₂ carbon budget with net-zero emission reached in 2060-2065 - mainly based on a globally uniform carbon price

Overview of the three models

	E3ME-FTT	GEM-E3-FIT	Imaclim-R
Model Type / Main features	Macro-econometric + BU evolutionary modules	CGE + nested-CES functions + BU modules	CGE + Leontief functions + BU modules
Macroeconomic theory	Non-equilibrium / Demand-driven / <i>No crowding-out</i>	Equilibrium / Supply-driven / <i>Crowding-out</i>	Equilibrium / Supply-driven / <i>Crowding-out</i>
Techno-economic flexibility	rather <i>High</i> / Fast technical change	rather <i>High</i> / Technical substitutions + limited market imperfections/rigidities	rather <i>Low</i> / Technical inertia + labour market imperfections/rigidities
Energy markets	Strategic behaviours	Perfect global markets	Strategic behaviours
Sector coverage	43 (70 in the EU)	52	19
Regional coverage and trade	71 countries/regions - bilateral trade	46 countries /regions - bilateral trade	12 countries/regions - global trade

Results : discounted cumulative GDP loss in 2050 (3% discount rate)

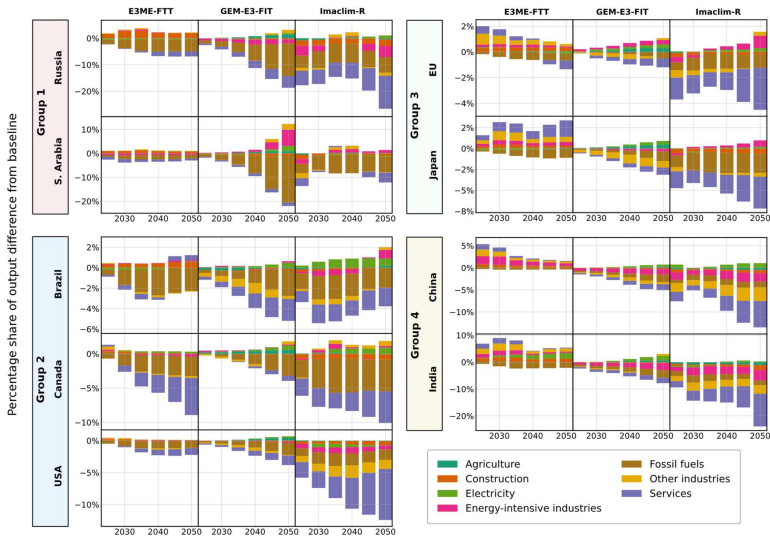


CO2 emissions/GDP (2019)	Energy exports / GDP (2019)
1,00	18%
0,82	25%
0,25	0%
0,34	5%
0,25	0%
0,17	-2%
0,22	-5%
0,75	-2%
0,93	-6%

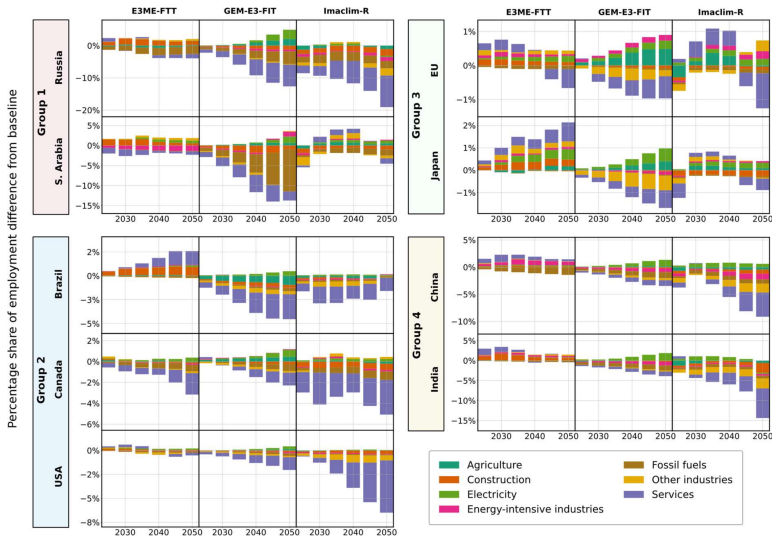
Synthesis of regional GDP impacts : four country groups

	Countries	Economic Carbon Intensity	Fossil Fuel Importer / Exporter status	Degree of Model Convergence	GDP impacts	Sources of uncertainty
1	Russia, Saudi Arabia	High	Exporter	Medium	Small to Large Negative	Techno-econ. flex., Energy markets
2	Brazil, Canada, USA	Medium	Exporter (uncompetitive)	Medium	Small to Moderate Negative	Techno-econ. flex., Energy markets
3	EU, Japan	Low	Importer	Medium	Small Positive or Negative	Crowding-out, Techno-econ. flex.
4	China, India	High	Importer	Low	Large Positive or Negative	Techno-econ. flex., Crowding-out, Low carb. tech. supply

Results : impacts on sectoral output



Results : impacts on sectoral employment



Main conclusions

- Heterogenous macroeconomic impacts of the net zero transition across regions and countries according to i) carbon intensity of the economy and ii) status of fossil fuel importer vs exporter
- Robust results : fossil fuel exporters would incur the largest economic impacts (variations linked to energy markets and technical inertia), fossil fuel importers and high income economies would incur limited aggregated economic impacts
- Uncertain impacts on fossil fuel importing and high carbon middle income economies : will depend on the capacity to smoothly phase-out high carbon technologies/activities, finance low-carbon capital and develop comparative advantages in low carbon tech. supply
- Fossil fuel production and jobs are most at risk, green jobs created in low carbon energy and agriculture, limited impacts on overall industry and construction (but internal structural change), service sectors reflect the macroeconomic situation

Thank you for your attention !

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