

# Economic structural change in global greenhouse gas emissions scenarios

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- **Structural change** : complementary and interrelated changes in various aspects of the economy : *sector composition of output and employment, industrial organization, technical change, demand and trade patterns*, etc.
- **A key driver of energy consumption and GHG emissions** (Blanco et al., 2014 ; Schäfer, 2005 ; Voigt et al., 2014)
- **Shapes abatement potentials and barriers/opportunities for climate change mitigation** (Jakob et al., 2014 ; Savona and Ciarli, 2019 ; Ciarli and Savona, 2019)
- **Is associated with main socio-economic impacts of climate policy** : sectoral costs and economic risks (Mercure et al., 2018) and opportunities (Dai et al. 2016) ; employment and job re-locations (Fragkos et al, 2018) ; purchasing power, income distribution, inequalities and poverty (Campagnolo and Davide, 2019)
- Implicit in IAM baseline scenarios (eg SSPs : Riahi et al. 2017) (with risks of bias in energy/GHG projections (Grubb et al. 2015))
- Specific studies with multi-sector economic IAMs

→ **A lens for systemic analysis of key socio-economic aspects of climate change scenarios and related issues : transformation pathways, SDGs, political feasibility, just transition, etc.**

# Multi-sector economic IAMs : frameworks to explore structural change dynamics

	Energy	Agriculture	Manufacturing	Services	Final demand		
Energy	<b>Inter-industry matrix</b> I/O coefficients (domestic + imported)				<b>Households consumption</b>	<b>Investment</b>	<b>Net exports</b>
Agriculture							
Manufacturing							
Services							
<b>Value-added</b>	<b>Labor intensity, income and wages</b>						
	<b>Capital intensity, income and rate of return</b>						
	<b>Total domestic production</b>						

## Main drivers of change

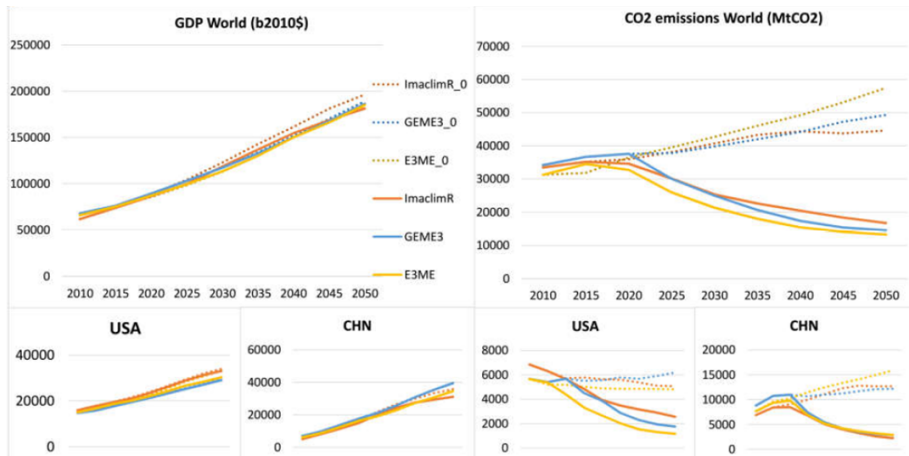
- Sectoral productivity (factor specific - inc energy, TFP)
- Inter-industry relationships (Input-Output coefficients)
- Consumption patterns (income distribution, savings, income elasticities, changes of preferences, etc.)
- Trade patterns (inc. competitiveness)
- Investment patterns

# A first multi-model study

## Two objectives

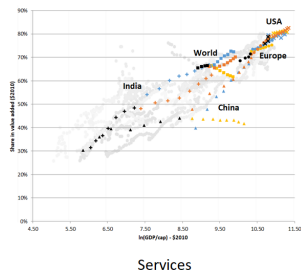
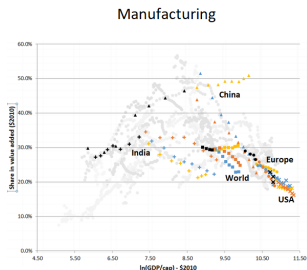
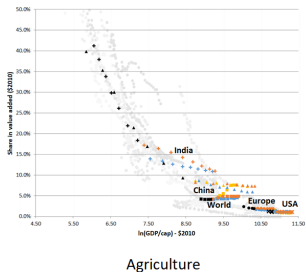
- ① Measuring and comparing structural change in a baseline scenario
  - ② Assessing incremental structural change in a 'standard' mitigation scenario
- Three multi-sector IAMs (E3ME, GEM-E3 and IMACLIM) capable to model endogenous structural change through comparable main mechanisms
  - Baseline scenarios based on SSP2 and harmonization of key parameters/variables (regional population and GDP, technology and resources availability, etc.) *except specific structural change drivers*
  - A 'standard' mitigation scenario : similar 2015-2050 CO<sub>2</sub> budgets (850-950 GtCO<sub>2</sub>); supply and market-driven policies (inc. carbon price)

# GDP and CO2 emissions pathways



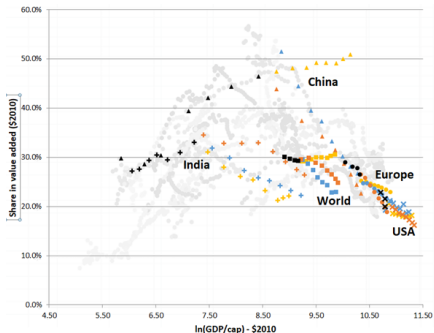
# Structural change in baseline (SSP2 scenarios)

Measurement indicators : **value-added** and employment shares of macro-sectors (Agriculture, Manufacturing and Services)

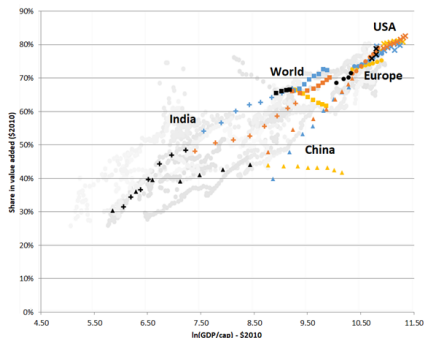


Source : World Bank data (1980-2010) and model simulations (2015-2050)

# Structural change in baseline (SSP2 scenarios)



Manufacturing

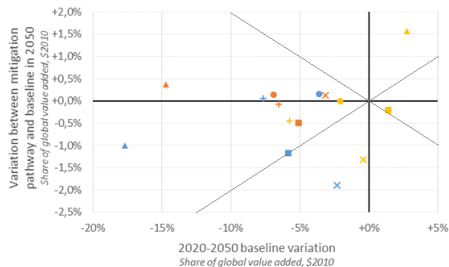


Services

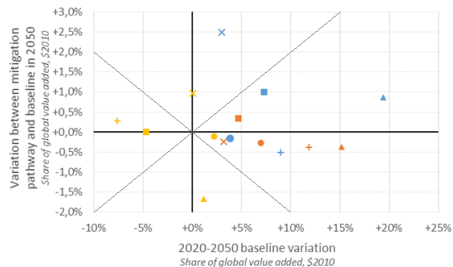
Source : World Bank data (1980-2010) and model simulations (2015-2050)

# Incremental structural change in mitigation scenarios - macroeconomic level

## Manufacturing

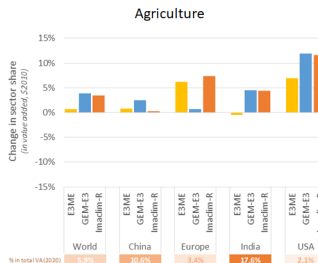
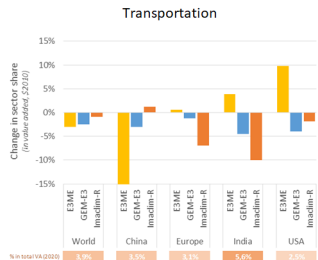
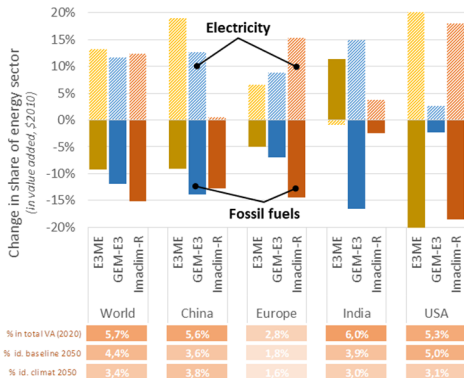


## Services





# Sectoral changes



# Conclusions and further research

- Uncertainty range for future structural change under same SSP baseline scenario
- Incremental macro-structural change in a 'standard' mitigation scenario of *second order* compared to baseline in general
- However significant structural change for specific sectors/industries
- Strong regional disparities

## Further research

- Develop structural change scenarios within the SSP framework (cf Leimbach and Marcolino, 2020)
- Develop multi-sector IAM analysis :
  - More robust structural change baselines (including post-COVID trends) : key drivers and implications for energy and emissions
  - Macroeconomic impacts of climate policy and implications for SDGs (growth, employment, etc.)
  - Structural change dynamics for key sectors (e.g fossil fuels)
  - Structural change in alternative low energy demand scenarios

*Thank you for your attention !*

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