What Can Models Do and Say – and What Not?

Energy – Economy – Environment Prospective

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Outline

Economic modeling issues

Represent techno-economic systems

- Emissions tracking
- Location of regulation instruments
- Abatements key mechanisms: Substitutions, Technical change, Sequestration...
- Behaviors, reactions and adjustments
- Vulnerability to damages

Formulate hypotheses, visions of the future

- Demography, technical progress, low-carbon technologies
- Pressure on natural resources (esp. fossil fuels)
- Geopolitics

Be able to reproduce the past?

The modeling "industry" evolution

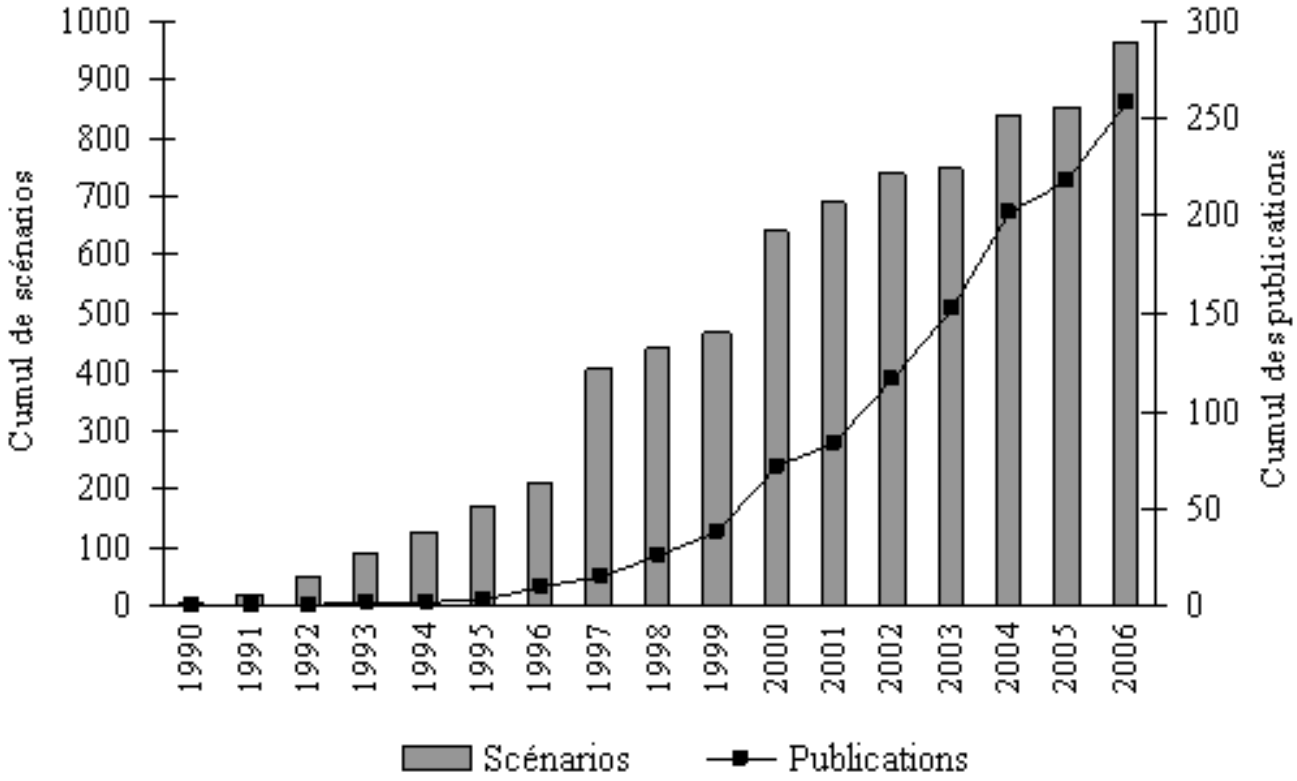
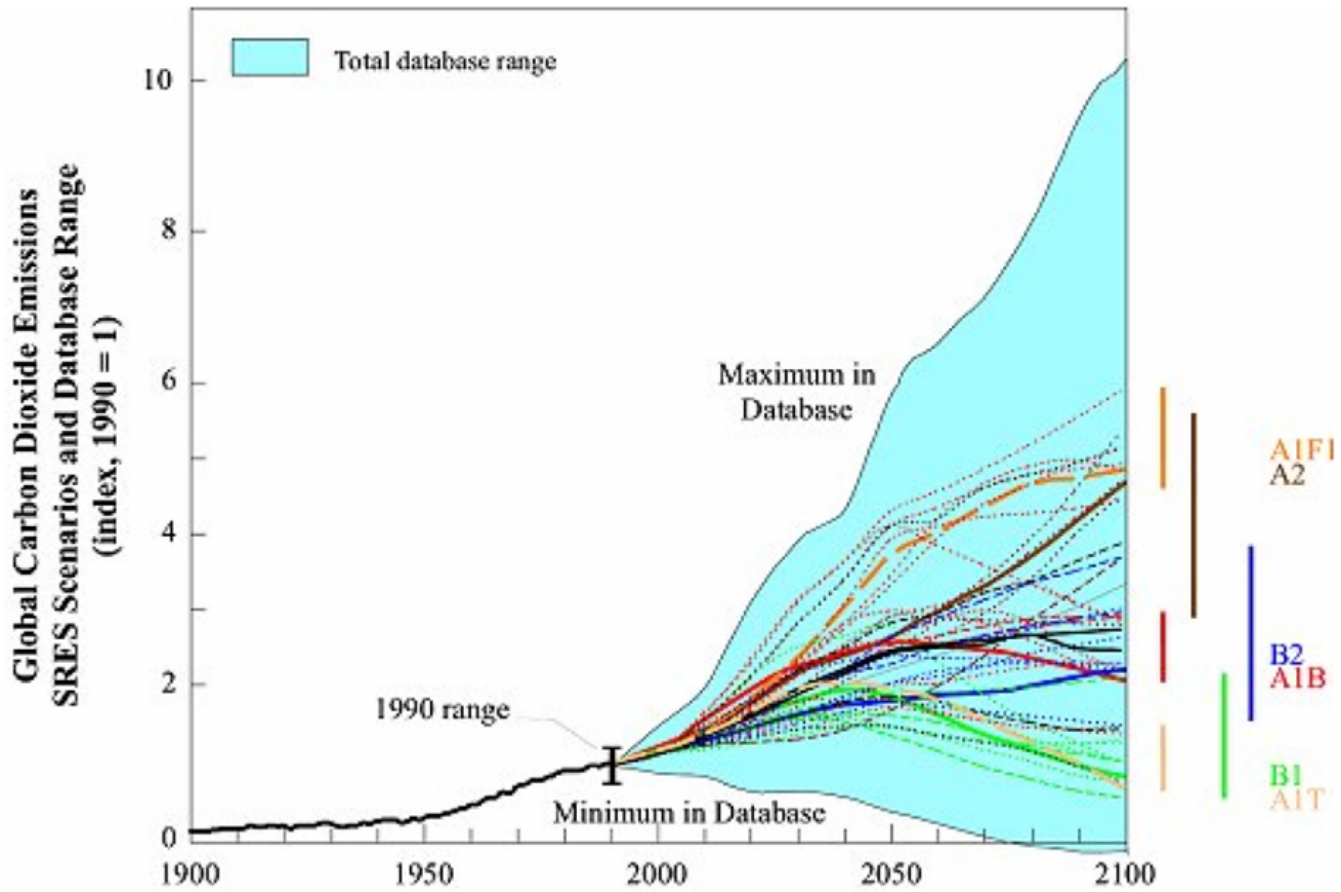


Figure: From: IPCC database (NIES)

Too many scenarios: loss of understandability



3 complementary methods

The different visions

- Exploratory approaches using "What if. . . ? " scenarios
- Normative approaches to suggest desirable alternatives
- Search for optimal strategies

Top-Down Models: general equilibrium models

Different model types

- Intertemporal optimization
- Recursive simulation
- Static analysis

Assets

- General equilibrium effects
- Financing constraints
- Fiscal structures
- International trade, balance of payments

Limits

- Production & consumption functions standardized and aggregated
- Simplifying hypotheses (optimality, rational anticipations...)
- Calibration on only 1 year (*99,99% of the models*)

Bottom-up models: an engineers vision

Principle

Optimization of the choices of technologies under constraints (including profits, investments & final demands)

Assets

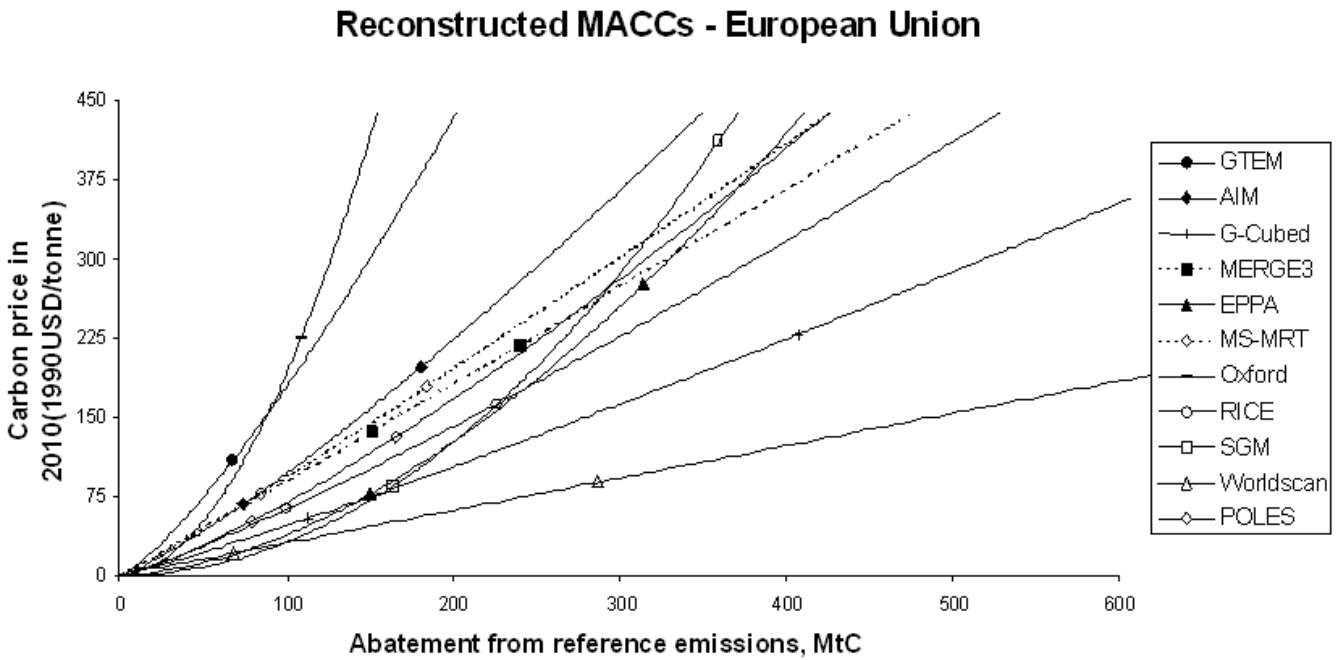
- Detailed representation of existing technologies
- Technological substitutions
- Inclusion of technological speicificities (esp. electricity)

Limits

- Exogenous demand (often as elasticity of aggregated macroeconomic module)
- No analysis of macroeconomic feedbacks

Bottom-Up vs. Top-Down: a long-lived opposition...
And uncertainties on costs evaluation ex ante

Differences stemming from methodology or calibration?



Source: EMF, CIRED

...combining the advantages of both Bottom-Up models and Top-Down models

Hybrid models development

- Pseudo-hybride (ETA-MACRO)
- Soft-link : coupling between two existing models
  - GEMINI E3 + MARKAL for Switzerland
  - Schäfer & Jacoby EPPA + MARKAL Transport
- Hard link: tools conceived as hybrid models
  - ObjECTS
  - SIMS
  - E3MG
  - Imaclim-R
  - Remind-R

Why so many modeling approaches?

- No ideal model of global economy
- Uncertainty on many parameters
- No empirical validation on historical trajectories
- Unresolved controversies on representation choices

Technical universes representation
Main hypotheses

Confusion on the status of the optimality

- Optimization vs. Simulation
- Status of the expectations and optimization of the "representative agent"

The expectations at the heart of the *political* problem

- A shift in meaning from the theory of rational expectations
- Little efforts to the dichotomy "myopic expectations vs. omniscient expectations"

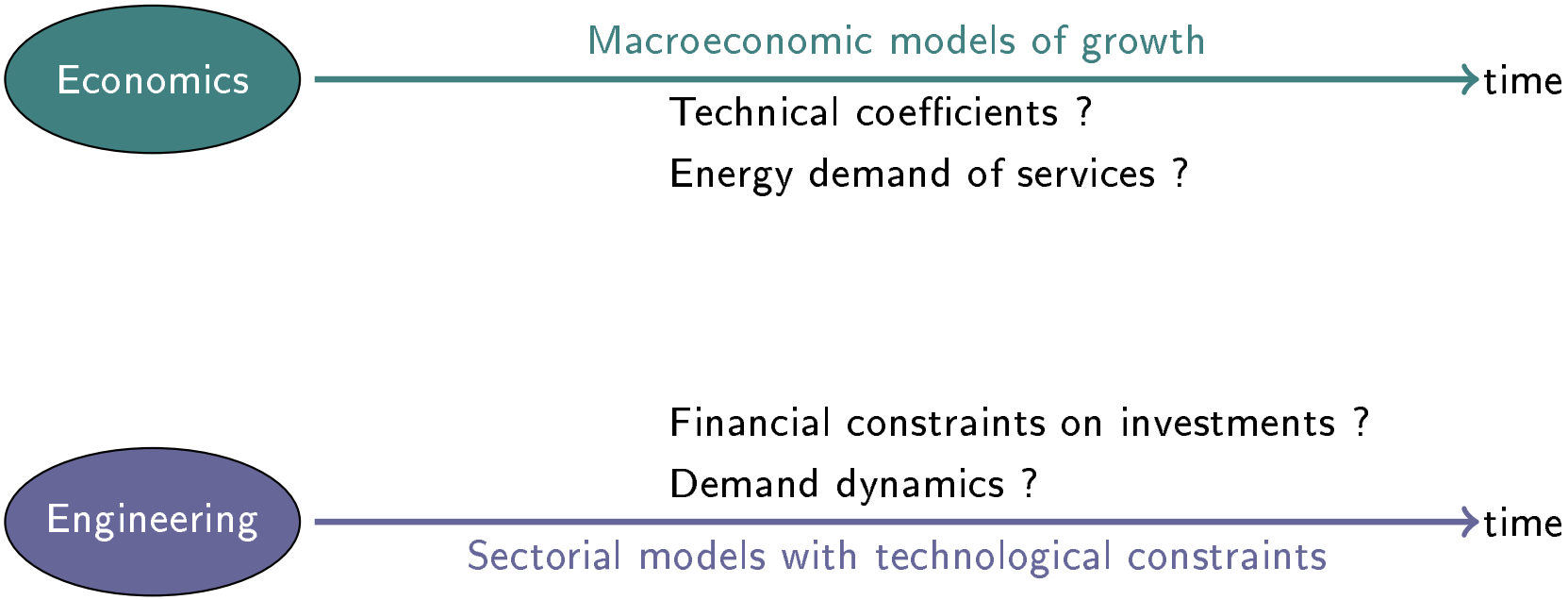
No regrets strategics and optimality

- Static or dynamic "No regrets decisions"
- Optimism of Bottom-Up models? Or the calibration issue?

Political issues are of utmost importance

- The **transition** issue
  - Not discussed with the existing tools
  - Ignored by the economics for the non-specialist public
  - Paradox between reasonable costs and cautious decision-makers
- Shed light on the political & economical **instruments**
- Bring together **decision** & **modeling**

The challenge of coherence between macroeconomic trajectories & technological evolutions



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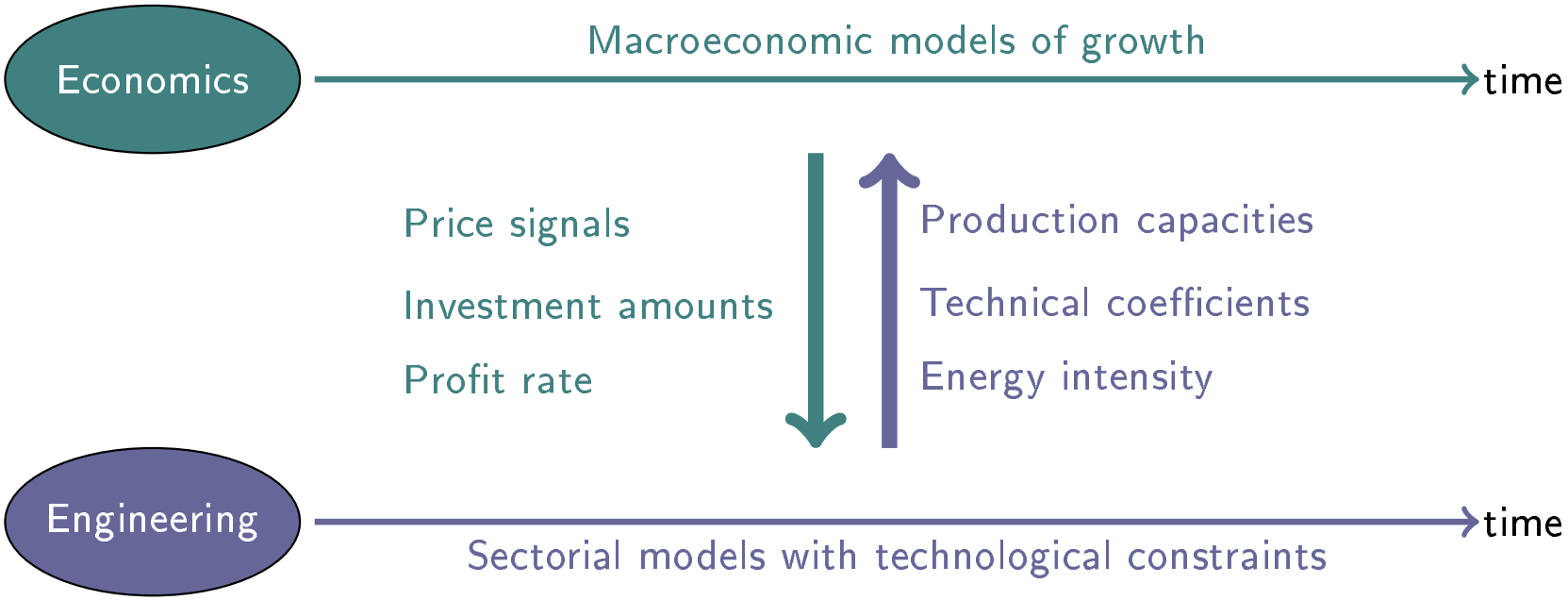
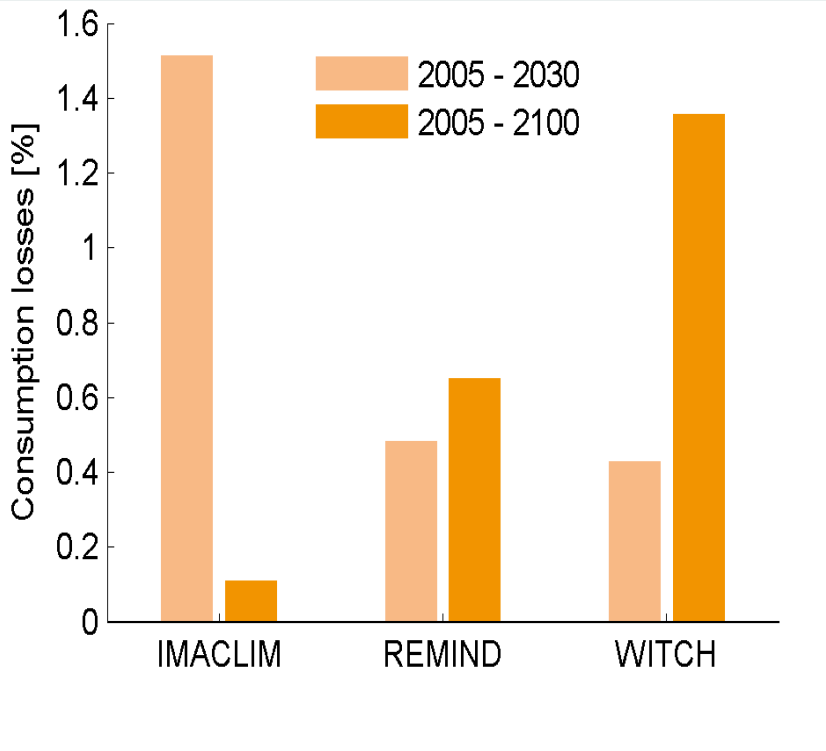
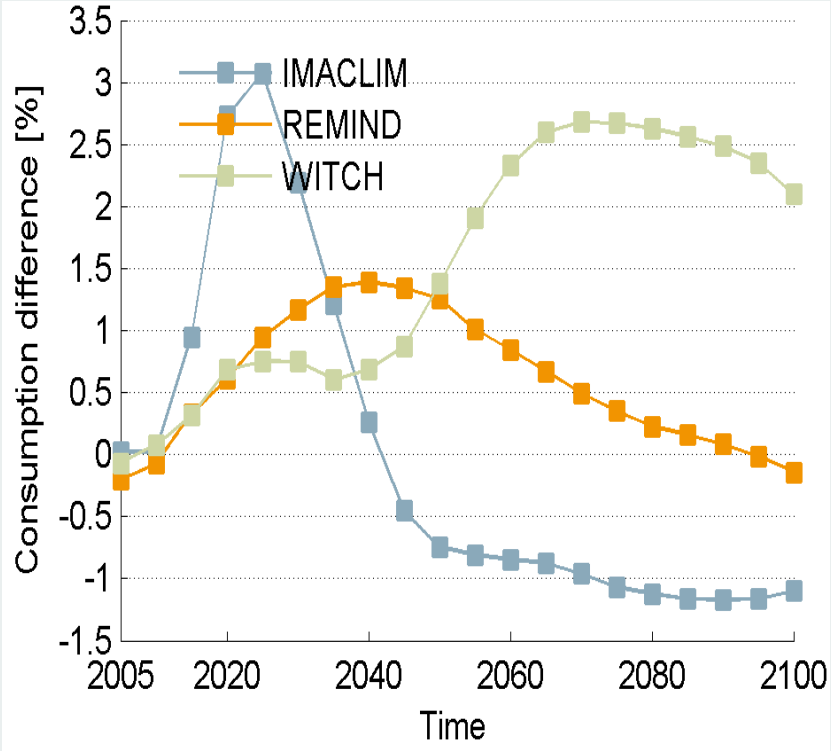


Results from the RECIPE study (see Luderer et al. 2009)

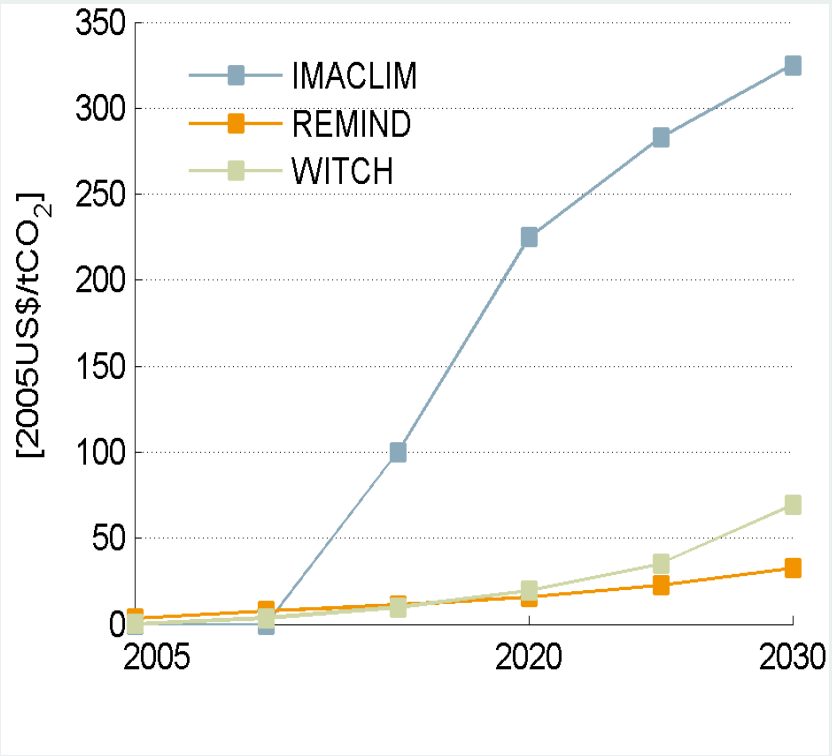
- Mitigation costs over the century range from 0.1% (IMACLIM-R) to 1.4% (WITCH) for the 450ppm scenario
- IMACLIM projects very high costs initally, followed by negative costs later
- For the more ambitious 410 ppm scenario, mitigation costs lie between 1.5% to 4%

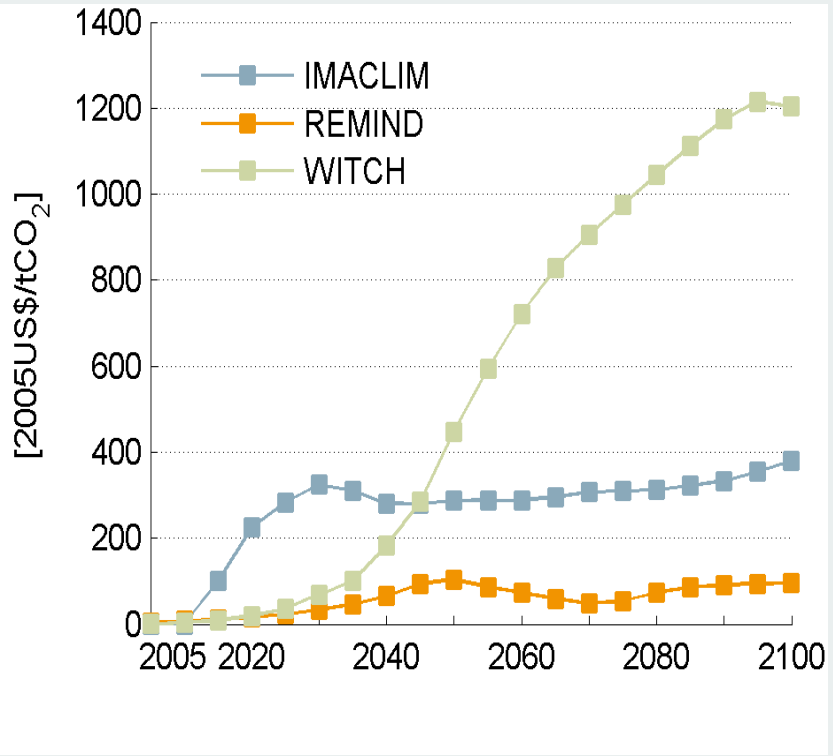




Results from the RECIPE study (see Luderer et al. 2009)

- IMACLIM requires high initial carbon price to induce learning and structural change
- Projected carbon prices in 2100 range from US$100 (REMIND) and US$1200 (WITCH)





Conclusion: A new design for climatic policies

Weakness of a climatic policy based only on carbon price

- Inducing important costs in emerging economies (thus need of stabilizing quickly expectations in a blurry environment)
- Not avoiding lock-in carbon intensive pathways

Necesity of considering beyond carbon prices

- Infrastructures policies
- Interactions with innovation processes beyond the energy sector

And see climatic policies as embedded in a larger political context with temporal dependencies

- Early investment in infrastructures
- Innovation emphasis in favor of low carbon technologies