Low Carbon Societies:
a challenging transition for an attractive future!

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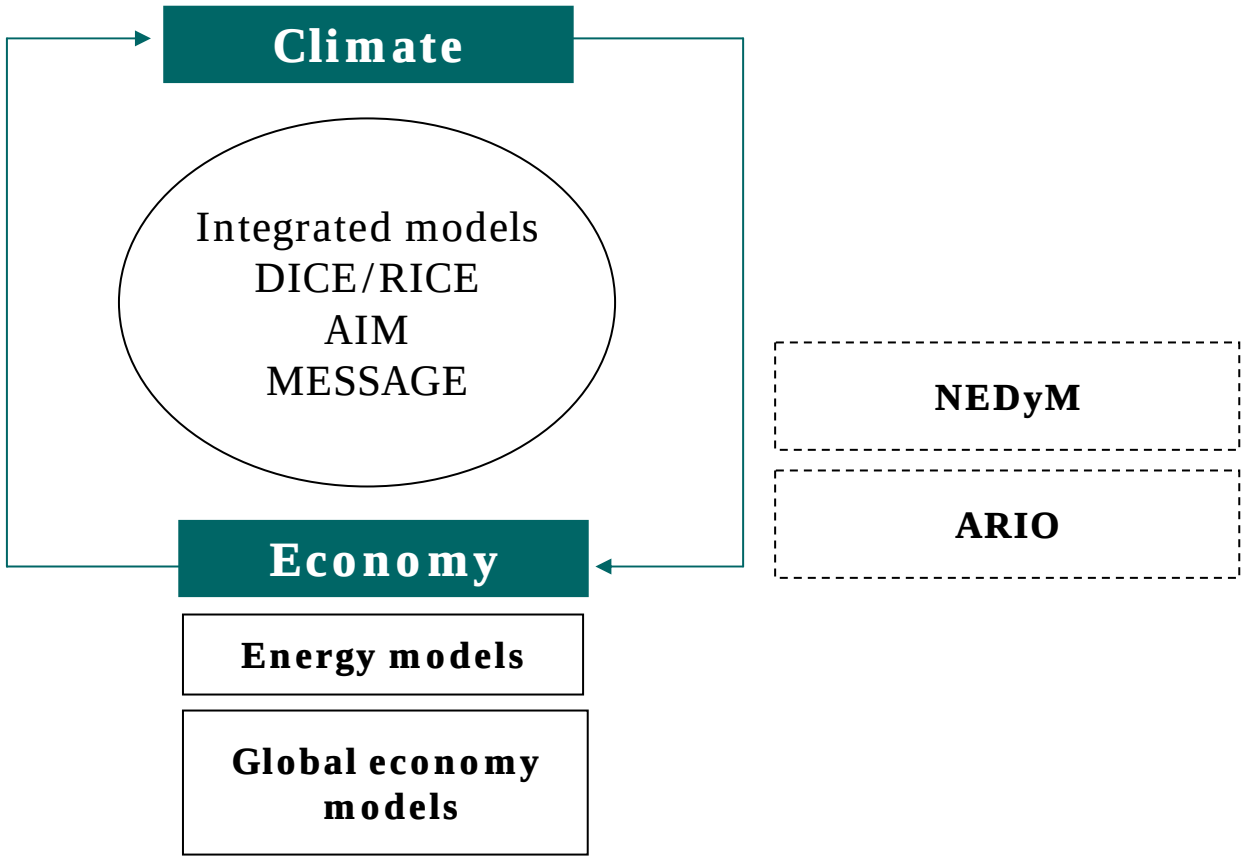
The economics of climate change



The challenge

Category	Radiative forcing (W/m^2)	CO_2 concentration[c] (ppm)	CO_2-eq concentration[c] (ppm)	Global mean temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity[b], [c] (°C)	Peaking year for CO_2 emissions[d]	Change in global CO_2 emissions in 2050 (% of 2000 emissions)[d]	No. of assessed scenarios
I	2.5-3.0	350-400	445-490	2.0-2.4	2000-2015	-85 to -50	6
II	3.0-3.5	400-440	490-535	2.4-2.8	2000-2020	-60 to -30	18
III	3.5-4.0	440-485	535-590	2.8-3.2	2010-2030	-30 to +5	21
IV	4.0-5.0	485-570	590-710	3.2-4.0	2020-2060	+10 to +60	118
V	5.0-6.0	570-660	710-855	4.0-4.9	2050-2080	+25 to +85	9
VI	6.0-7.5	660-790	855-1130	4.9-6.1	2060-2090	+90 to +140	5
						Total	177

Transition

Long Run

Results from a recent ‘LCS’ project

- All kind of models represented, global and national studies
- Halving emissions in 2050 feasible with existing technologies, but no free choice, all options
- The carbon value ranges between 100 and 330 $/tCO2 in 2050, linear or exponential growth
- Additional measures (standards, pubic investments) for many scenarios
- GDP change between a small gain and a 2-3% loss in 2050

Results gathered by IPCC : encouraging?

Stabilization costs are likely to be limited to a few percents of global GDP

Table SPM.4: *Estimated global macro-economic costs in 2030[a] for least-cost trajectories towards different long-term stabilization levels.[b], [c]*

Stabilization levels (ppm CO_2-eq)	Median GDP reduction[d] (%)	Range of GDP reduction[d], [e] (%)	Reduction of average annual GDP growth rates[d], [f] (percentage points)
590-710	0.2	-0.6-1.2	<0.06
535-590	0.6	0.2-2.5	<0.1
445-535[g]	not available	<3	<0.12

Table SPM.6: *Estimated global macro-economic costs in 2050 relative to the baseline for least-cost trajectories towards different long-term stabilization targets[a] [3.3, 13.3]*

Stabilization levels (ppm CO_2-eq)	Median GDP reduction[b] (%)	Range of GDP reduction[b], [c] (%)	Reduction of average annual GDP growth rates[b], [d] (percentage points)
590-710	0.5	-1 - 2	<0.05
535-590	1.3	slightly negative - 4	<0.1
445-535[e]	not available	<5.5	<0.12

- Encouraging?
- Questioning
- Likely to be false?

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Results gathered by IPCC : encouraging?

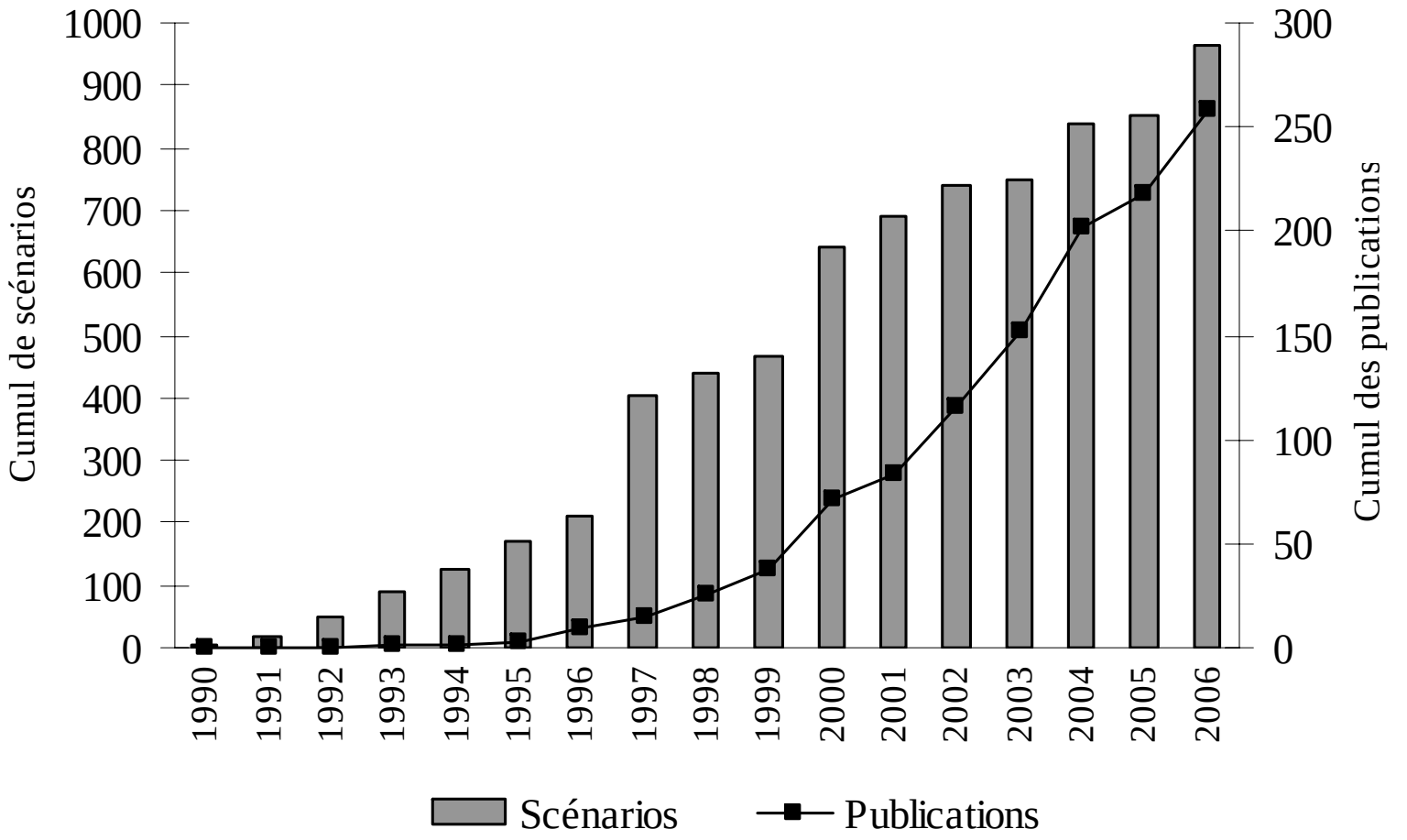
… under the condition of very specific assumptions:

‘Most models use a global **least cost approach** to mitigation portfolios and with universal emissions trading, assuming **transparent markets**, **no transaction cost**, and thus **perfect implementation** of mitigation measures throughout the 21st century.’
(AR4 WGIII SPM Box 3)

A set of theoretical rules...
...that are not followed in real decisions

Rules from economic theory	Observations
Separability between Equity / Efficiency	No consensus on equity rules has hampered the discussion about the more efficient international system
Cost minimization requires a uniform carbon value (tax or tradable quotas)	Complex and country-specific P&M
Carbon value should increase exponentially	With the current system of quotas, no control on the future profile of the carbon value
Total costs remain below a few percent of GDP	General reluctance to adopt ambitious targets

The « small industry » of energy-economy models



IPCC database, 2007 version (NIES)

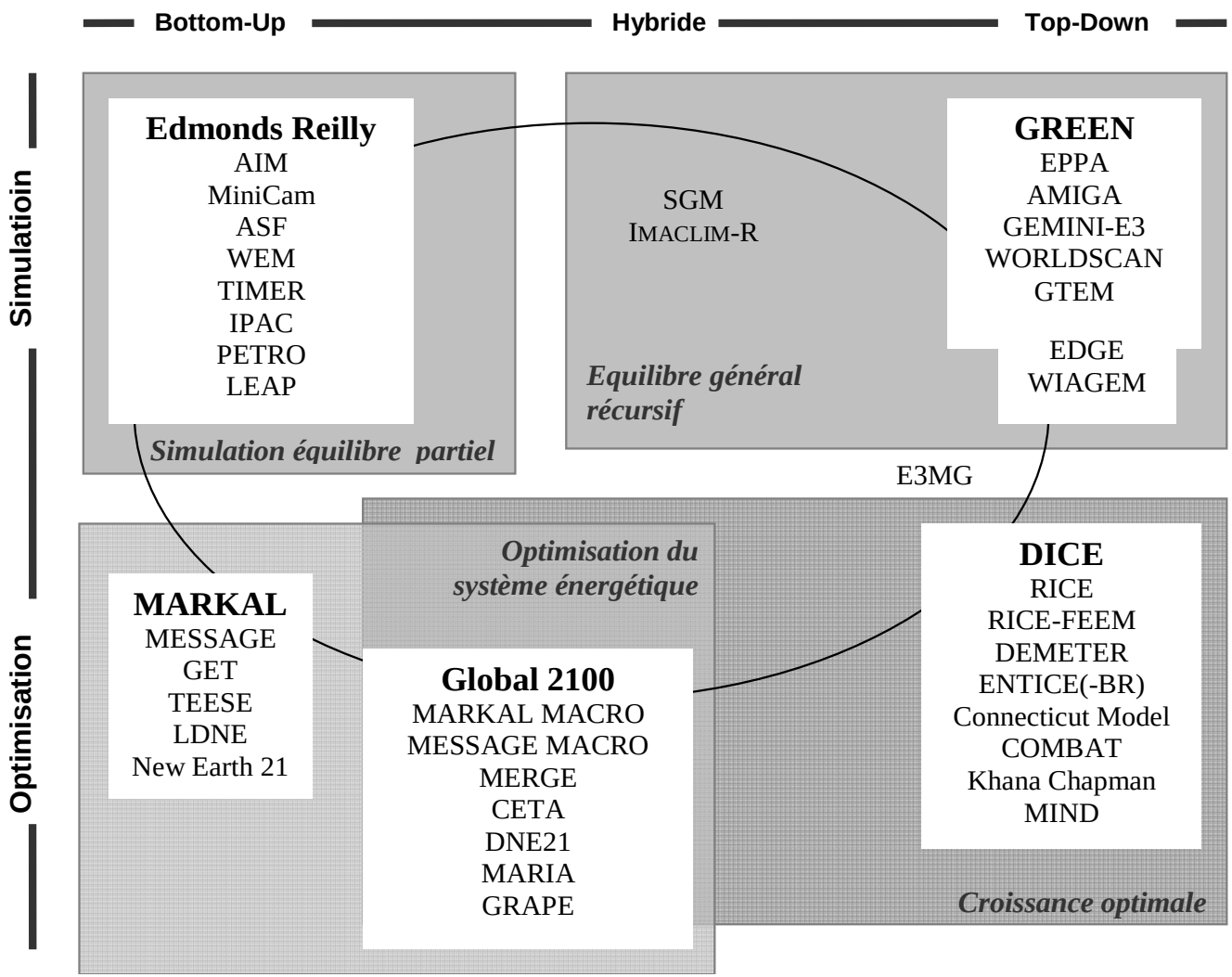
Upstream: how many models? What diversity?

AIM	69		IPAC emission	2
AMIGA	2		KFA-STE	1
ASF	22		Khanna Chapman	1
CETA	19		LDNE	13
Climate Research and Policy Synthesis Model	10		LEAP	2
COMBAT	6		MARIA	39
Connecticut Model	10		MARKAL	16
DEMETER	20		MARKAL MACRO	5
DICE	11		MERGE	36
DNE21	8		MESSAGE	39
E3MG	3		MESSAGE MACRO	5
EDGE	2		MIND 1.1	3
ENTICE BR	4		MiniCAM	58
EPPA	30		MIT	7
EURICES/PRO	1		New Earth 21	4
FEEM RICE	19		PAGE	8
FLAMES	4		PETRO	12
FUND 2.7	2		Policy Evaluation Framwork Model	1
GEMINI E3	2		RAND	2
GET	12		RICE	8
Global 2100	3		SGM	49
GRAPE	15		SIMA	1
GREEN	5		TARGETS	3
GTEM	2		TEESE	2
IEA – World Energy Model	6		UK-ECCO	1
IMACLIM-R	3		WIAGEM	3
IMAGE TIMER	46		WorldScan	28
ICAM	13			

Bottom-Up vs Top-Down: nothing new?

			Top down		
SAR, 1995	**Bottom up**		GE	Intertemporal Optimization	Macro econometric
TAR, 2001	Energy system Optimization	Simulations Partial Equilibrium	Input-Output ; GE		Short run Keynesians Macroeconometric
Edenhofer et al., 2006	Models of the energy System	Simulations	GE	Optimal Growth	Simulations, System dynamics

5 ‘old’ paradigms?



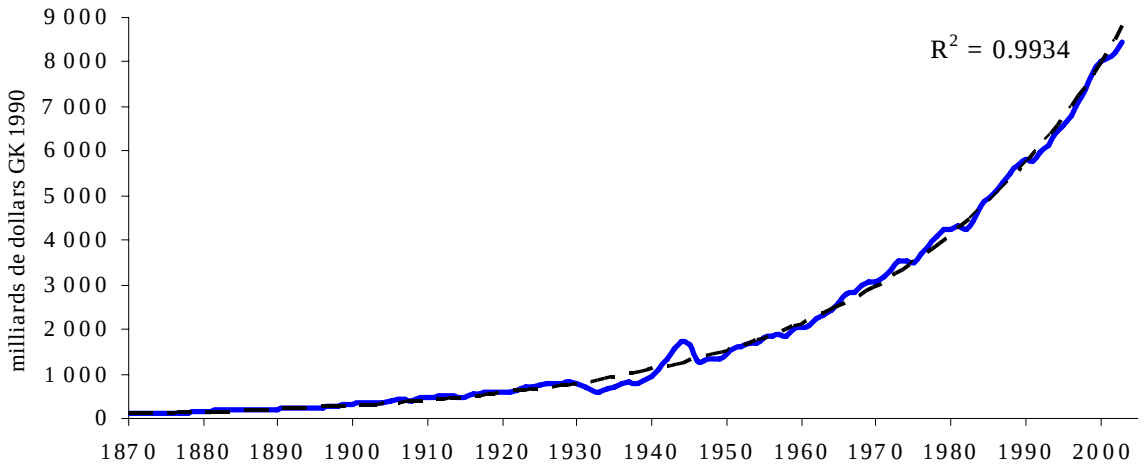
Why do models coexist?

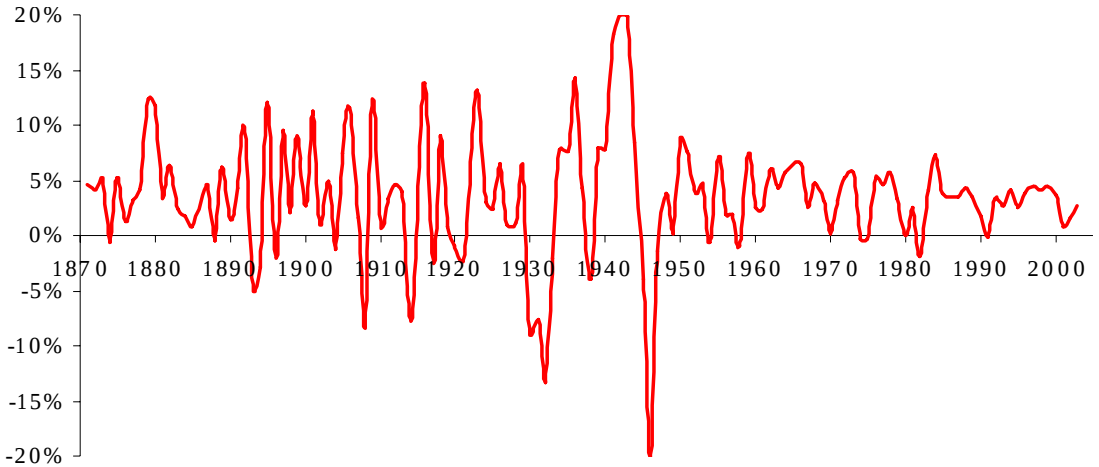
- No ideal model of the global economy
- Ongoing controversies on several subjects in economic theory
- The mask of parameter uncertainties
- No empiric validation on historical trajectories (except E3MG)

Persistent dissatisfactions in three transversal dimensions

- Economic growth
- The space of available techniques
- Optimality and expectations

1. Models incorporate only stable and smooth pathways





- Business cycles
- Partial capacity utilization
- Underemployment
- Exhange rates adjustments, etc.

2. The representation of technical frontiers: the stumbing block of the BU vs TD gap

- *Top-Down*: agreggate production functions are extrapolated **with few robustness**; don’t provide any tangible representation of techniques and physical variables

- *Bottom-Up*: discrete technologies can only apply to limited sectors, with no accounting for ***system effects***

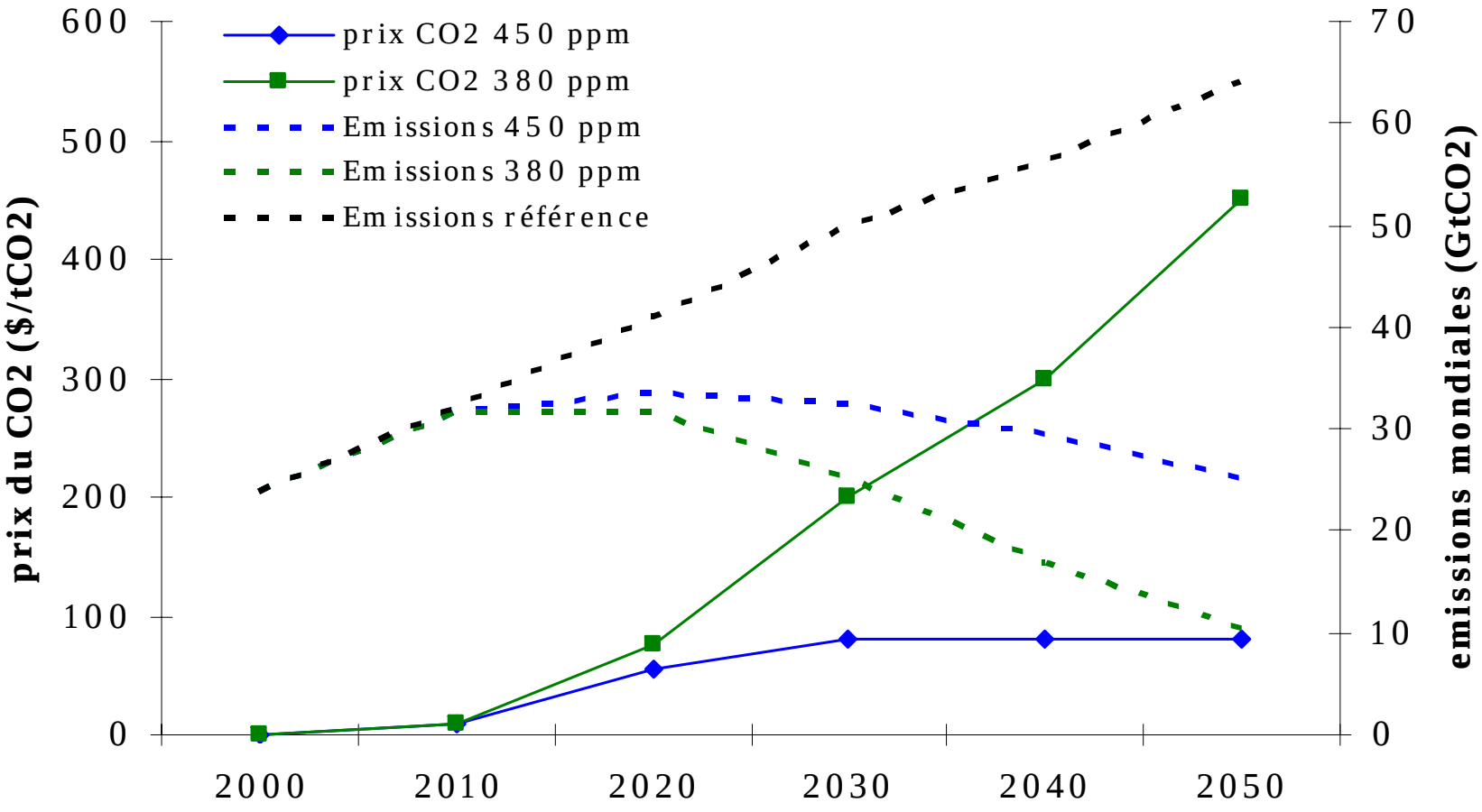
3. First best assumptions

- Which use of optimality?
  - Optimisation vs. Simulation
  - Representative agent has to be « an elegant and striking informational economy » (Muellbauer, 1976). Still right when he is infinitely forward looking?

> «…about the use made of the intertemporally-optimizing representative agent. (...) **I see no remeeding social value in using this construction** (…) It adds little or nothing to the story anyway, while encumbering it with **unnecessary implausibilities** and complexities.» (Solow, 1994)

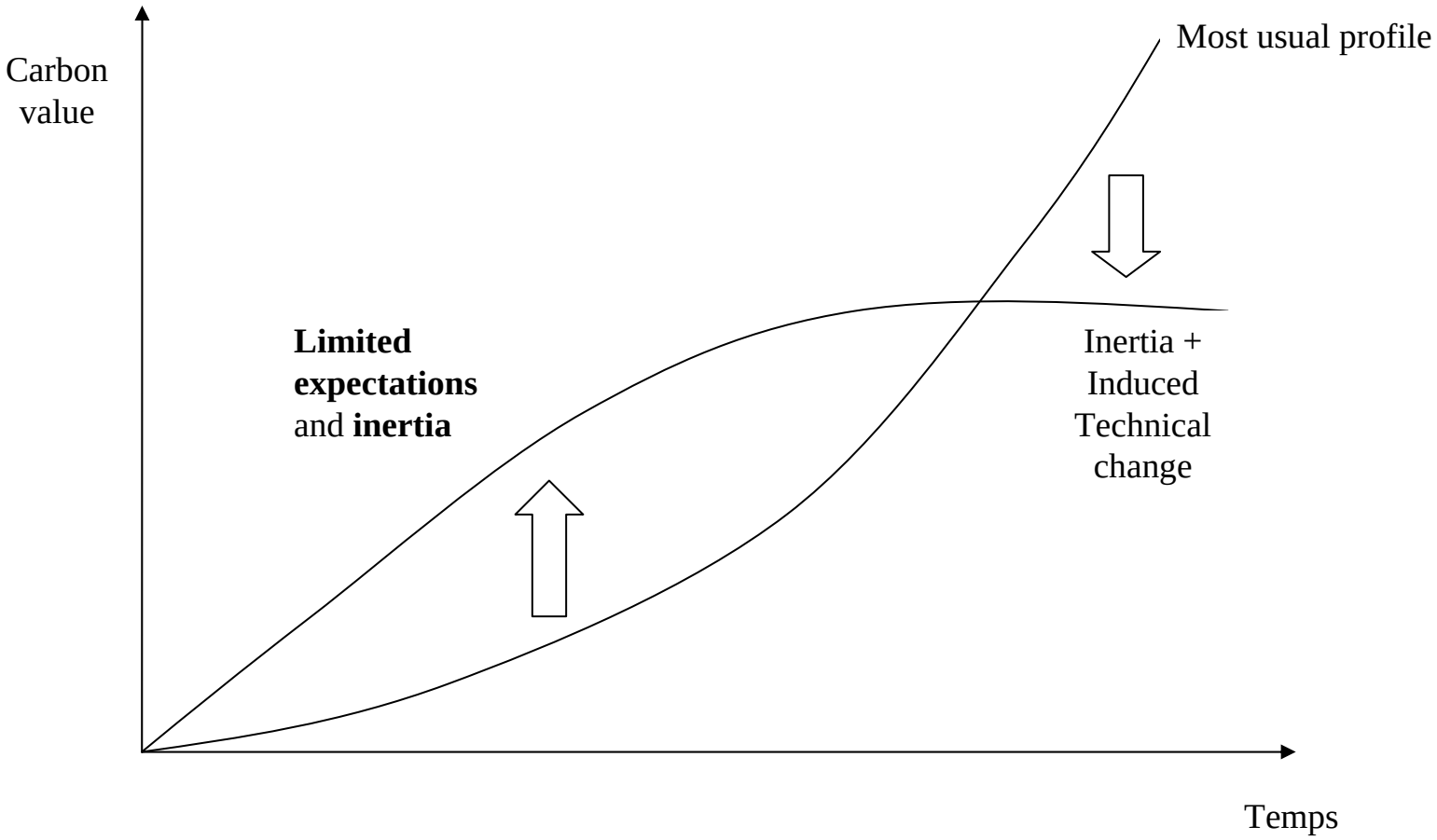
- *A gap between expectation theory and modeling pratices:*
  - From rational expectations to ‘perfect’ expectations?
  - Very few efforts to overcome the bipolar situation: ‘myopic behavior vs. perfect knowledge of the futur’

The interactions between inertia, bounded expectations and induced technical change completely change the carbon price profile

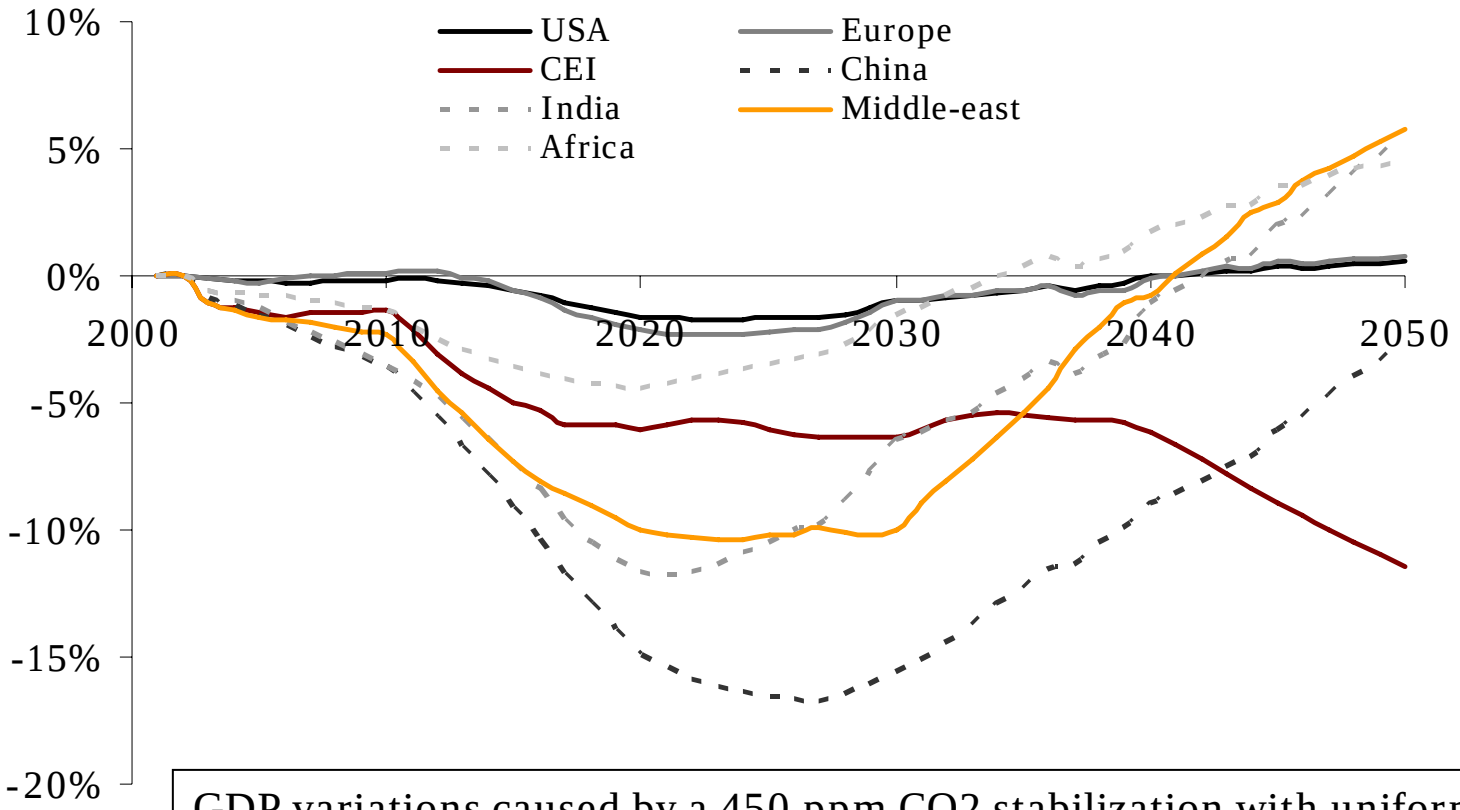


Crassous, 2008

Why could we need a different profile for carbon value ?

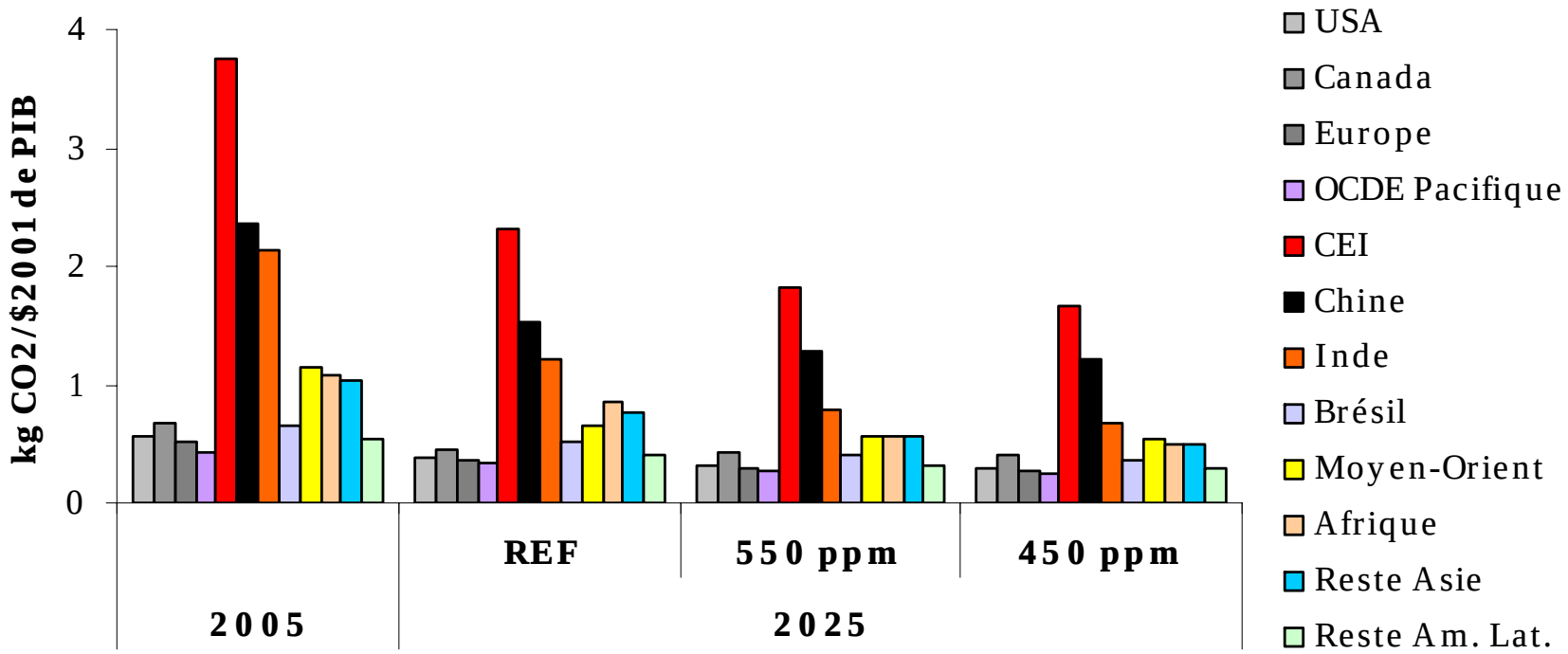


Lesson #2: transition costs are the heaviest part of the global burden



GDP variations caused by a 450 ppm CO2 stabilization with uniform taxes, domestic recycling and without transfers

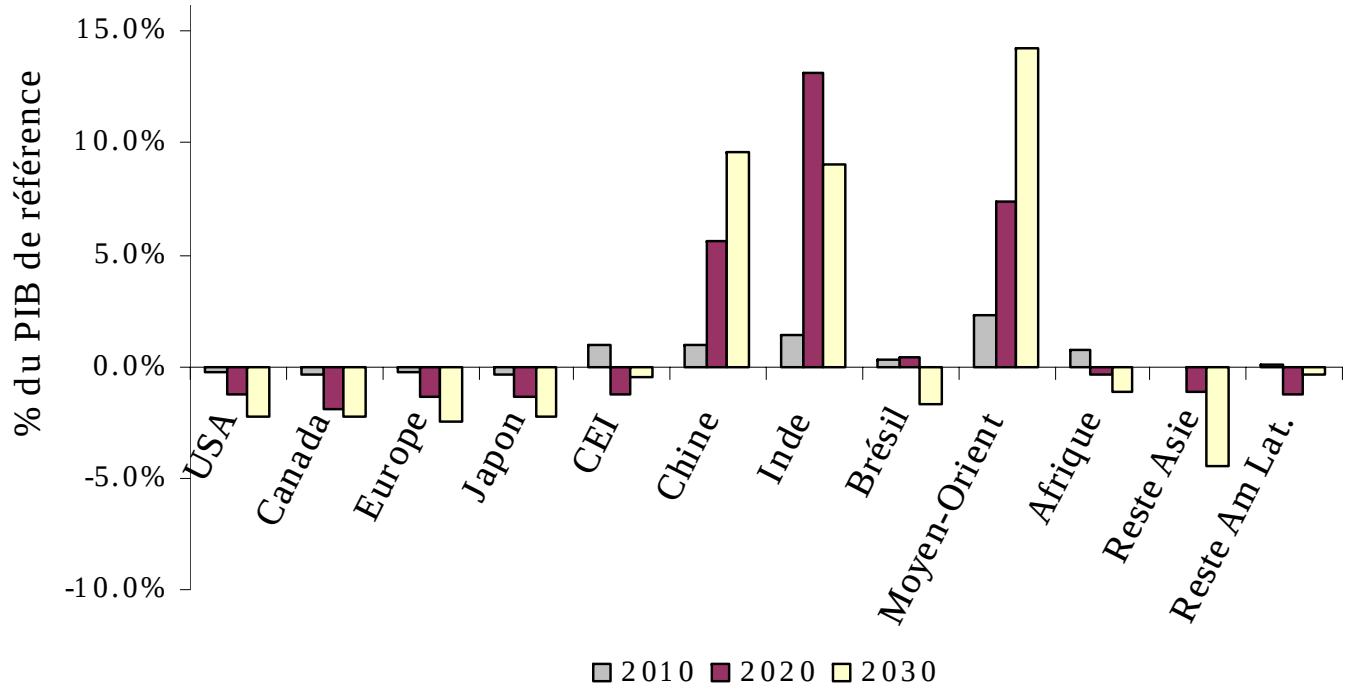
A ‘competition’ between the steeply increasing tax and the slow shift to low carbon technologies and pratices



Carbon intensity of real GDP, 2005 and 2025

International transfers are not likely to solve the issue of transition costs

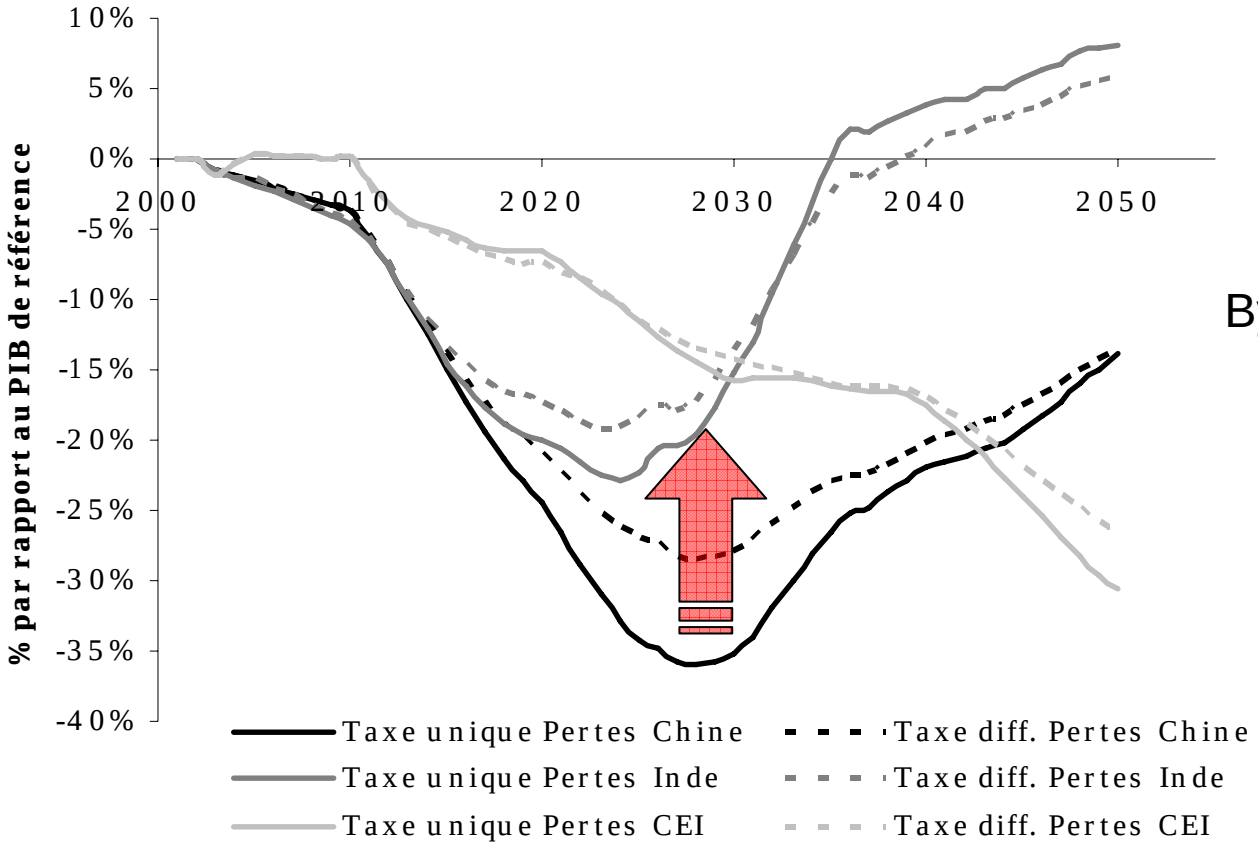
- An impossible consensus about the ‘right’ quota allocation rule
- Potential transfers are unacceptable and may be harmful for all economies!



Orders of magnitude of the transfers required
to equate GDP losses (%) with a unique price

How to solve the issue of transition?

- Differentiated prices (regions/sectors)?

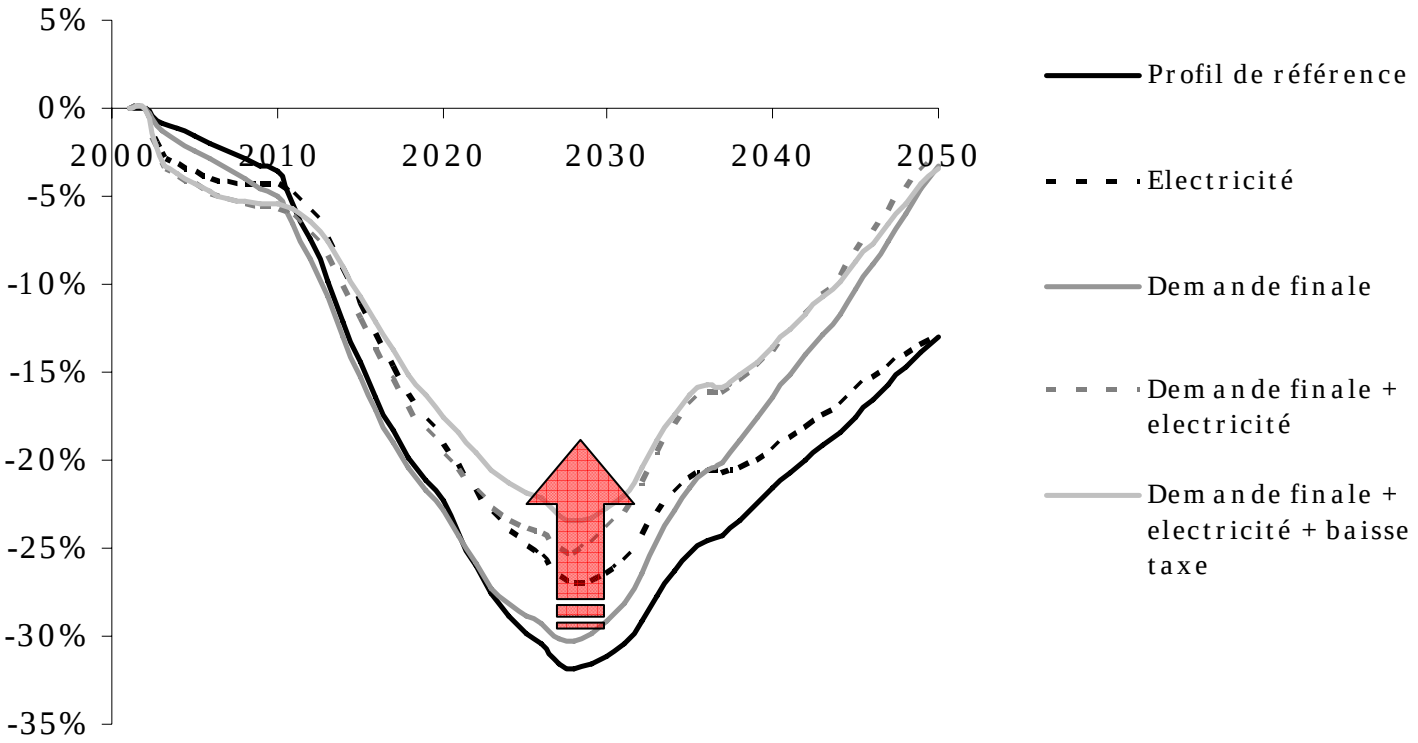


By Regions

How to solve the issue of transition?

- Differentiated prices (regions/sectors)?

By Sectors



May help, but not solve the issue…

How to solve the issue of transition?

- Differentiated prices (regions/sectors)?
- Help to improve expectations (stable price signals, caution for low carbon investments)
- Reduce inertia, begin now!
- Strong redistribution issue (consumers, sectors, countries)
- Back to the initial Kyoto deal with subsidiarity rules
- Use the whole bunch of available P&M, including infrastructure policies for the long-run

Conclusion

- Do not deny the risks of high transition costs. At the heart of transition costs : inertia + expectations
- Those risks must not be a fatality; find ways to secure the transition pathway to LCS
- Future research must fulfill the need for much more subtle assessments, inc. sensitivity tests