CENTRE INTERNATIONAL DE RECHERCHE SUR L'ENVIRONNEMENT ET LE DÉVELOPPEMENT

C.I.R.E.D.

Chaire Modélisation prospective au service du développement durable

Mitigation costs in second-best economies: time profile of emission reductions and sequencing of accompanying measures

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Introduction

- Standard approach for assessing the costs of climate policies: first best framework

  → Optimal functioning of the economy, "Carbon price only" policies, Optimal emission trajectory

BUT:

- Time profile of emission reduction will result from a political decision that may depart from economic optimization

  → it forces to consider the emission objective as an exogenous constraint on the economy

- Economic interactions have a second best nature where inertias and imperfect foresights drive economic dynamics away from its optimal trajectories

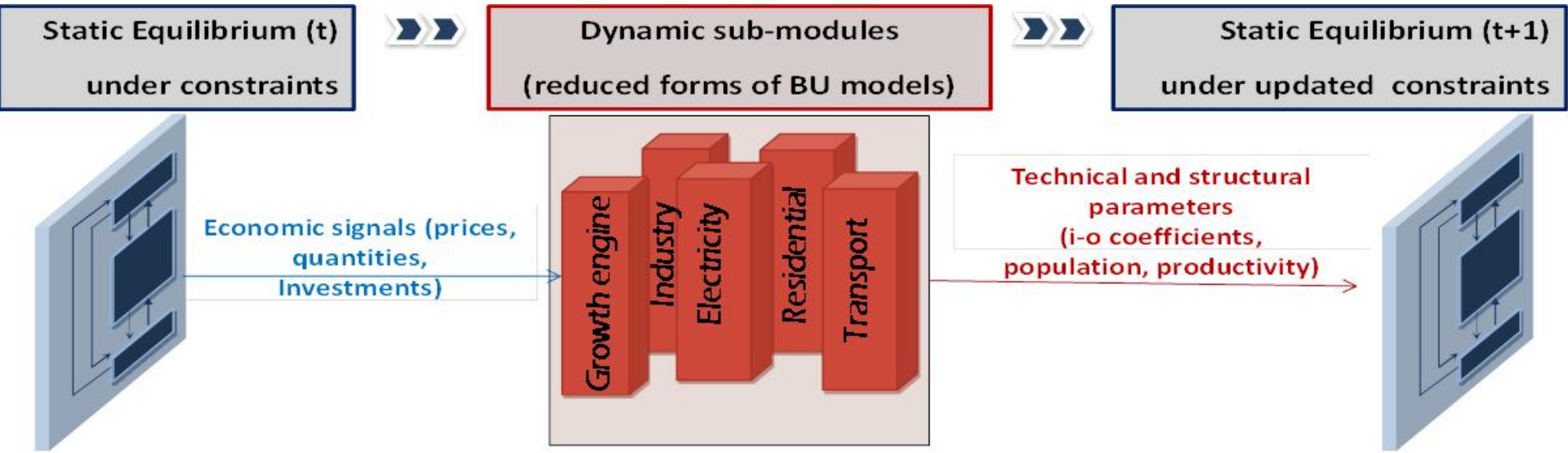
  → need of complementary instruments other than carbon pricing alone

➢ A second best modeling framework

➢ Sequencing carbon pricing and accompanying measures

The Imaclim-R model

multi-region and **multi-sector Dynamic General Equilibrium**

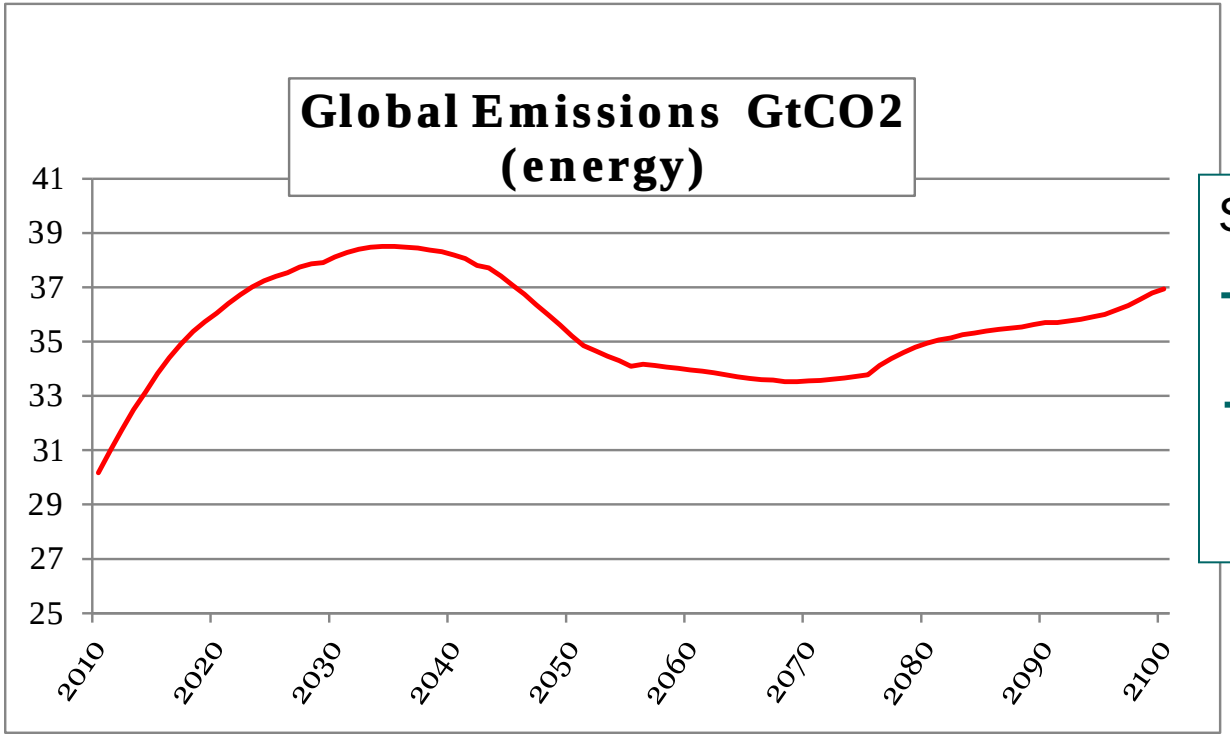


- Hybrid matrix: consistency between money and physical quantities
  (Calibrated on GTAP & IEA energy balances)
- **Annual time step, recursive succession of :**
  - **Static equilibria: second best economy**

    → **imperfect expectations, market imperfections, partial use of production factors (unemployment)**
  - **Dynamic modules:**

    evolution of technical and structural constraints → inertia

The baseline scenario BAU



Sustained economic activity:

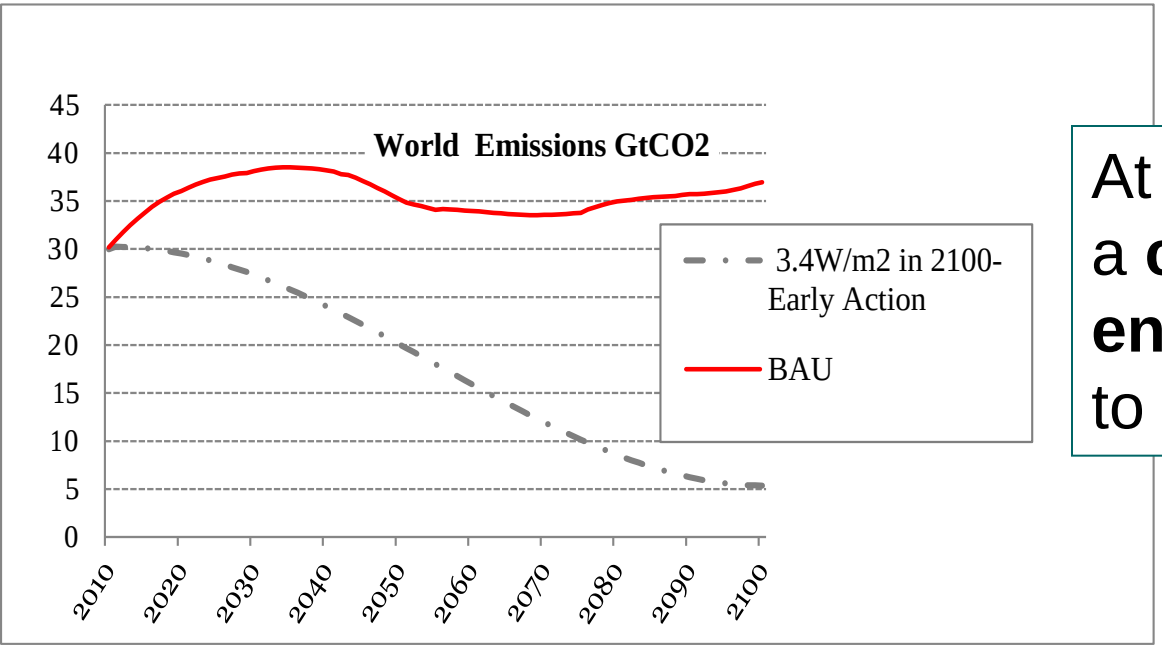
- → Average growth rate ~2%
- → Large diffusion of Energy Efficiency ~2% global increase in av.

Lower class of the SRES and post-SRES emissions range

→ Total carbon budget = 946 GtC

Climate policy scenarios

Given a **prescribed** CO2 emission objective

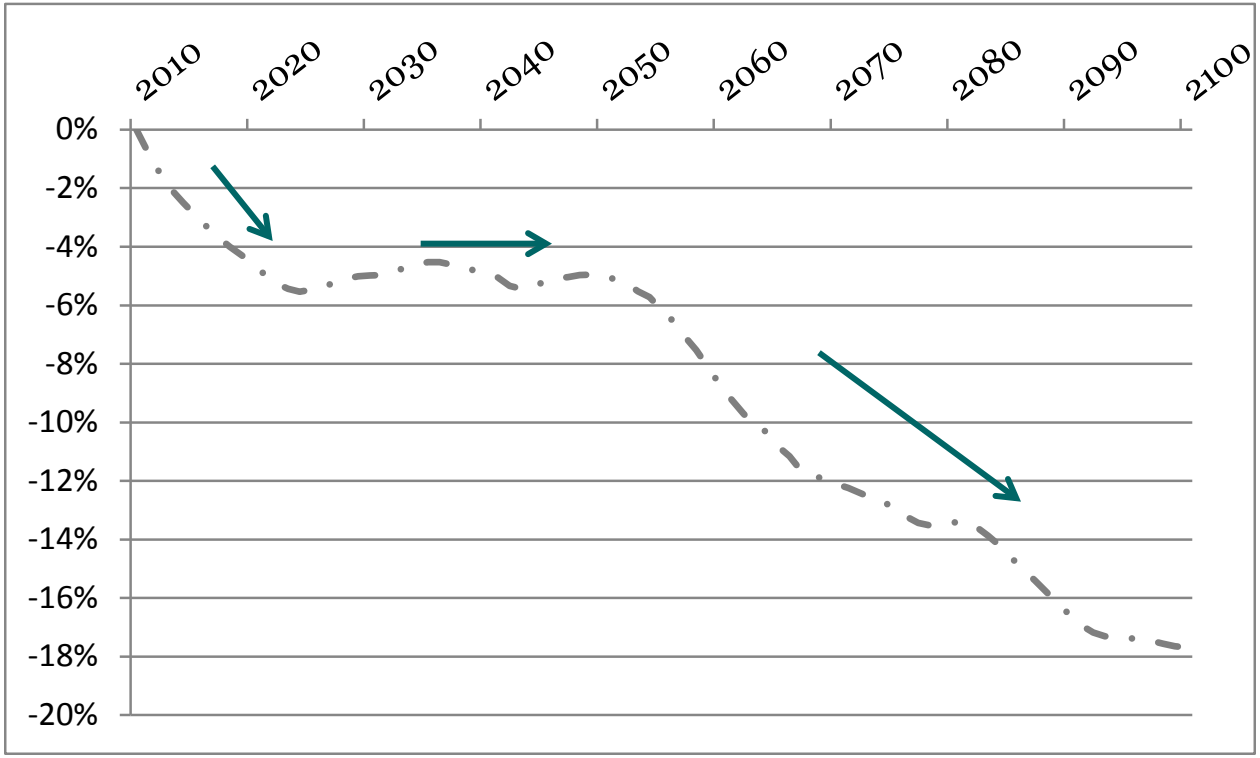


At each date,
a **carbon price** is **endogenously calculated** to curve carbon emissions

What consequences in terms of **macro-economic costs** ?

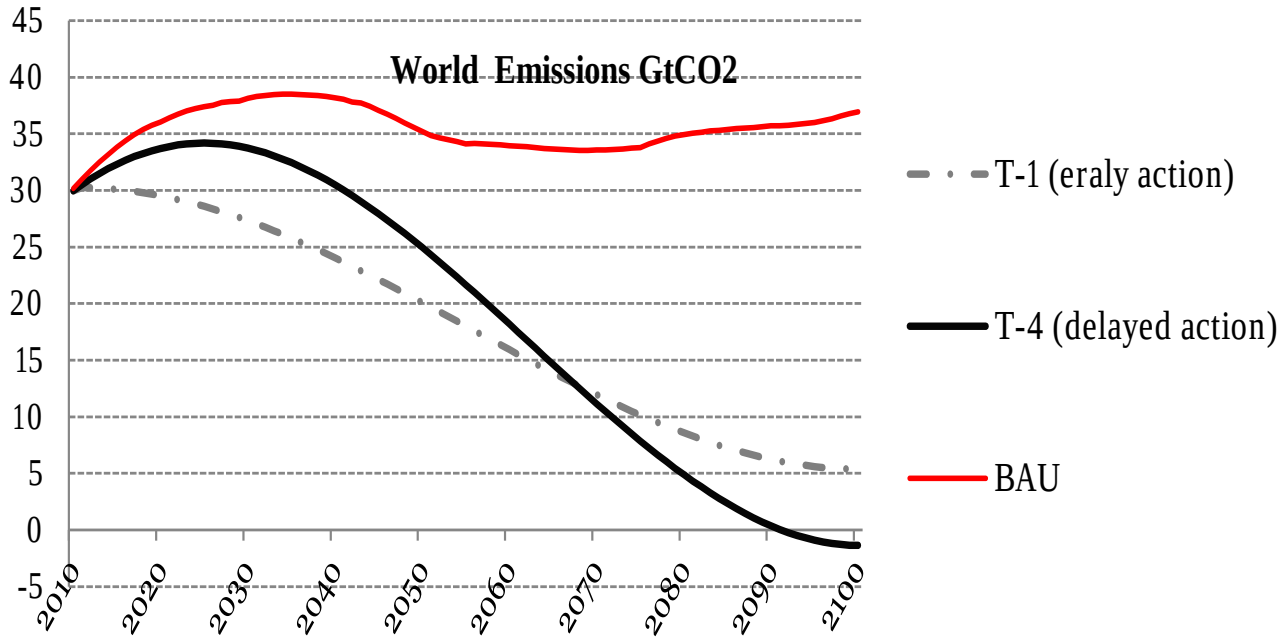
Mitigation costs

Global GDP variation between climate and reference scenarios



- **Short term**: Imperfect expectations + Inertia → High carbon price
  → High production costs
- **Medium term**: Mitigation potential in residential, industrial and power sectors
- **Long term** : Transport infrastructure inertia + High mobility needs → High carbon prices

Mitigation costs & the timing of emissions reductions



A family of 4 Carbon trajectories, which differ in terms of:

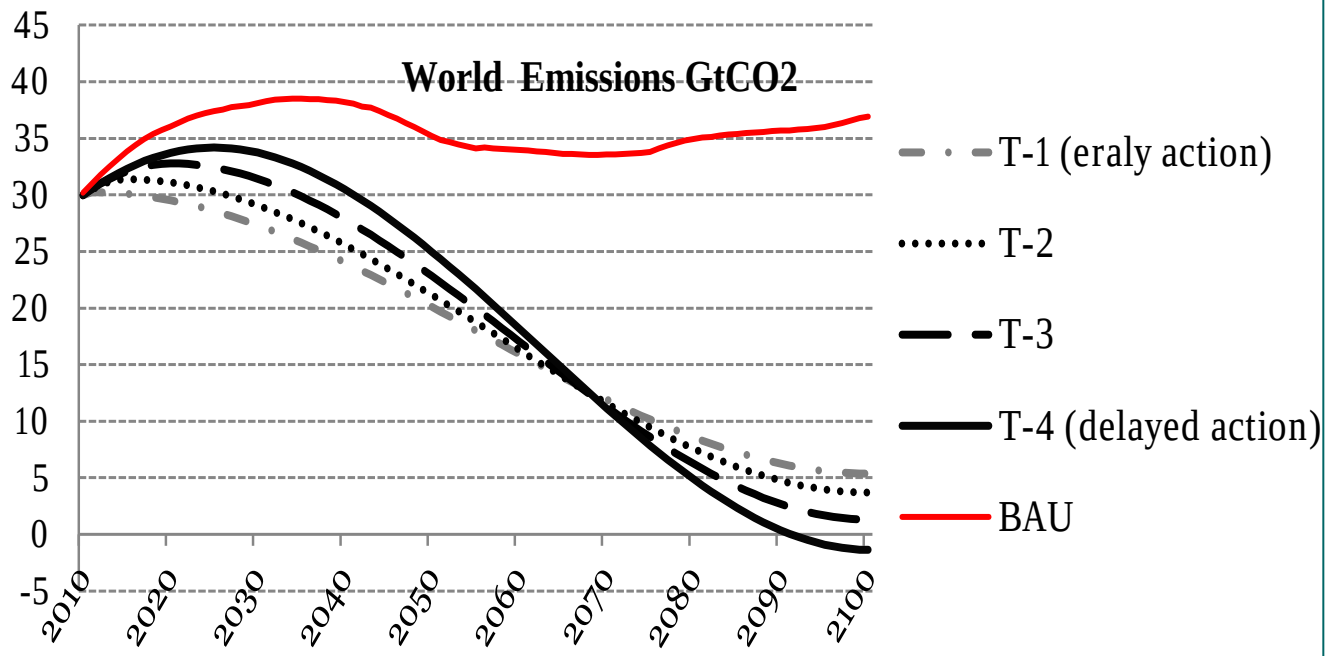
- date of and level of the emission peak
- Long Term stabilization level

→ All lead to the same radiative forcing in 2100: 3.4W/m2 in 2100

→ (climate module)

Early action vs Delayed action

Mitigation costs & the timing of emissions reductions



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Early action vs Delayed action

Mitigation costs & the timing of emissions reductions

- The dependence of aggregated mitigation costs over these time profile of emission reductions
- Comparison of the discounted costs for two values of the discount rate: 7% (short-term vision) and 1% (Long term vision)

➢ **The sensitivity of GDP losses to the emission profile depends on the time horizon considered**

Mitigation costs & the timing of emissions reductions

Short term perspective

	Dsicount rate	
	7%	**1%**
T-1 (Early)	-3.2%	-9.6%
T-2	-2.7%	-9.7%
T-3	-2.1%	-10.0%
T-4 (Delayed)	-1.8%	-11.1%

More rapid decarbonization efforts unsurprisingly enhance the costs…..

A delayed action reduces the costs of the Short term ……

BUT …

Mitigation costs & the timing of emissions reductions

Long term perspective

	Dsicount rate	
	7%	**1%**
T-1 (Early)	-3.2%	-9.6%
T-2	-2.7%	-9.7%
T-3	-2.1%	-10.0%
T-4 (Delayed)	-1.8%	-11.1%

The later the most important efforts will be made, the more costly it will be !

Delaying action of mitigation emissions reduces Short Term costs, but shifts the issue toward the Long Term

Complementary instruments are necessary !

Carbon price and Fiscal reform…

- Revenues of carbon tax: Used to reduce pre-existing labor taxes
  - → Foster high employment during the carbon transition
  - → Avoid the explosion of production costs

➢ Whatever the time horizon and whatever the timing of emission reductions, the **recycling on labor taxes proves to reduce mitigation costs**

➢ These measures to moderate production costs are particularly important during the first phase of the climate policy….in which energy costs rise and technical change is limited by strong inertias…

Reforming the fiscal system … a way to reduce the short term effects of the mitigation policies

	Hsld	*Labor*
T-1 (Early)	-3.2%	-1.9%
T-2	-2.7%	-1.5%
T-3	-2.1%	-1.2%
T-4 (Delayed)	-1.8%	-1.0%

Short term (7% disc)

	Hsld	*Labor*
T-1 (Early)	-9.6%	-7.53%
T-2	-9.7%	-7.46%
T-3	-10.0%	-7.65%
T-4 (Delayed)	-11.1%	-8.62%

Long term (1% disc)

~ **42%** av.	Reduction of the losses *wrt.* Carbon price only scenario	~ **22%** av.

A fiscal reform is really efficient on the short term….

Complementary measures are necessary to improve the long term situation…..

Carbon price, Fiscal reform and Infrastructure policy

- The issue of long term costs' persistence is linked to the specific dynamics on the transportation sector.

- Carbon pricing and fiscal reform are completed by measures aimed at controlling the long term dynamics of transport-related emissions:
  - Reduction of mobility needs
  - Shift towards low-carbon modes

Early action on transportation infrastructures … a way to reduce the long term effects of the mitigation policies

	Hsld	*Labor + InfraPol*
T-1 (Early)	-9.6%	-4.3%
T-2	-9.7%	-4.2%
T-3	-10.0%	-4.4%
T-4 (Delayed)	-11.1%	-5.0%

Long term (1% disc)

Reduction of the losses *wrt.* Carbon price only scenario ~**56%** av.

Long lived infrastructure policy plays a role in the long term…

It allows meeting the same climate objectives

with far more moderate GDP losses

and possible postponing of mitigation action

Conclusion

- Dealing with the timing of emission reduction induces a time shift of mitigation costs according to the period where most efforts are conducted
- Recycling carbon tax revenues towards lower labor taxes and early action on transportation infrastructures significantly reduce mitigation costs both on the short term and on the long term.
- The sequencing of these options is closely related to the intertemporal tradeoff on emissions reductions
- These complementary measures are as important as the time profile of emissions for mitigation costs

Thank you ...!!!

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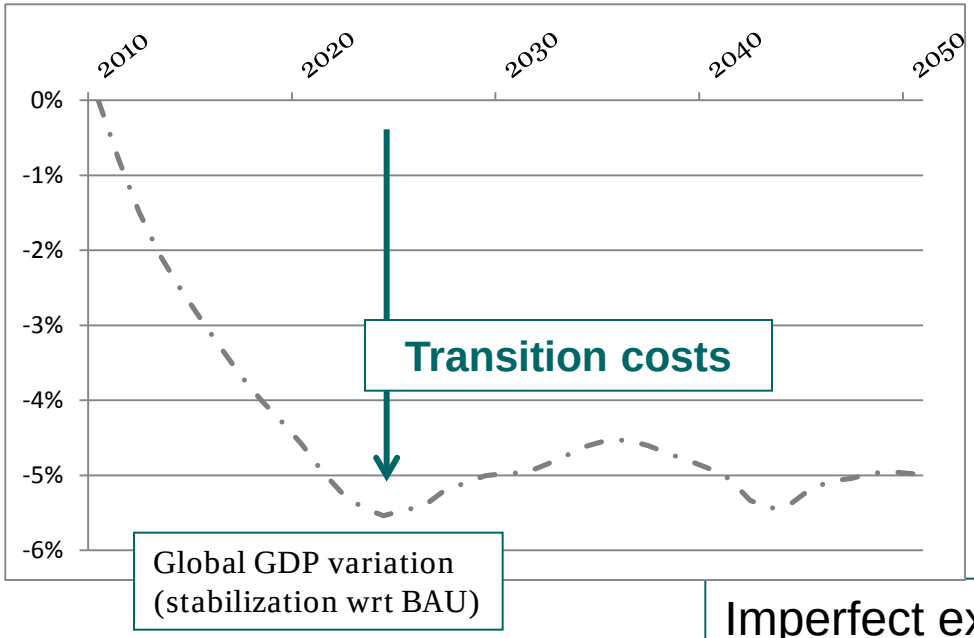
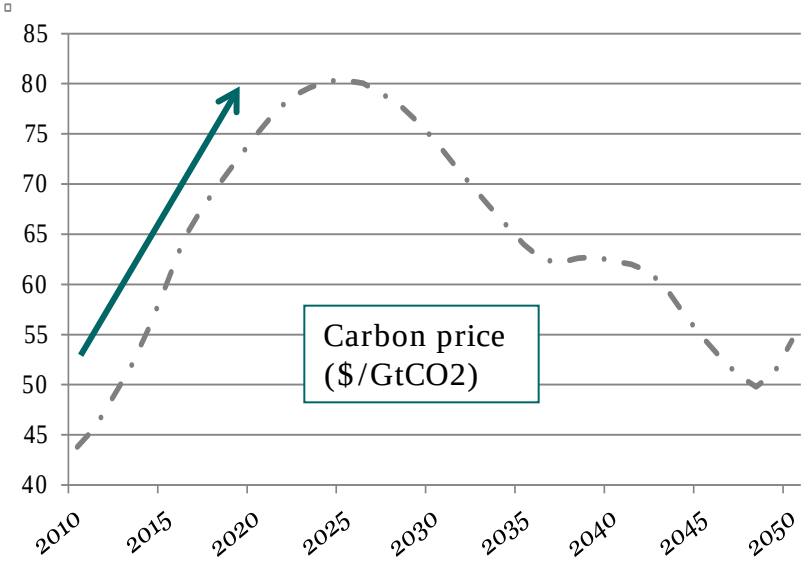
Appendix

Mitigation costs
Short term





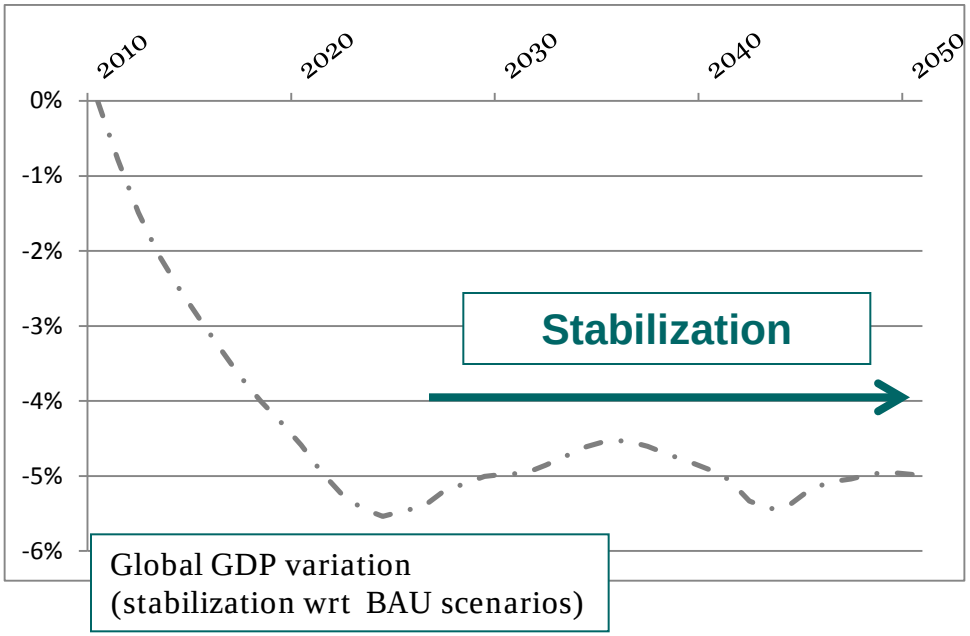
Imperfect expectations
Inertia on installed capital & end-use equipment

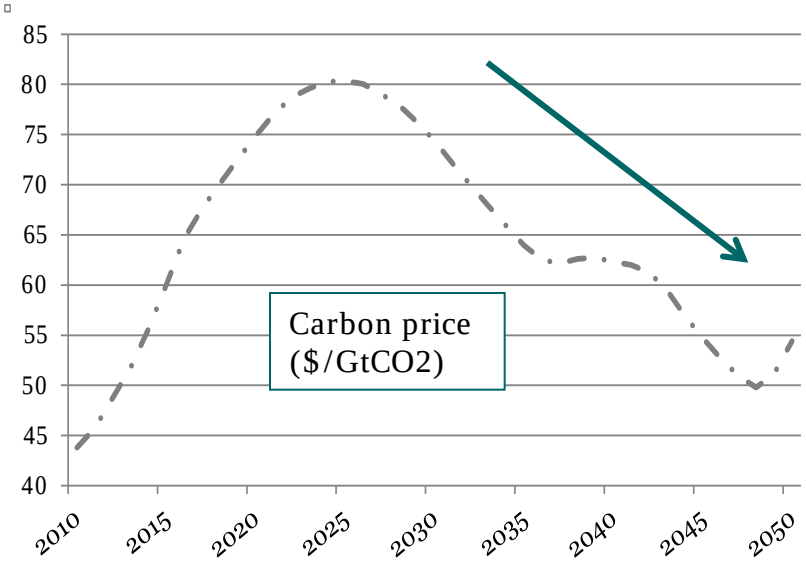
→ Only high carbon prices to redirect investments choices

Increase of
- Production costs & Consumption prices
- Unemployment

→ High transition costs

Mitigation costs
Medium term





- Induced Technological change, learning by doing
- Consumption structure change

⇒

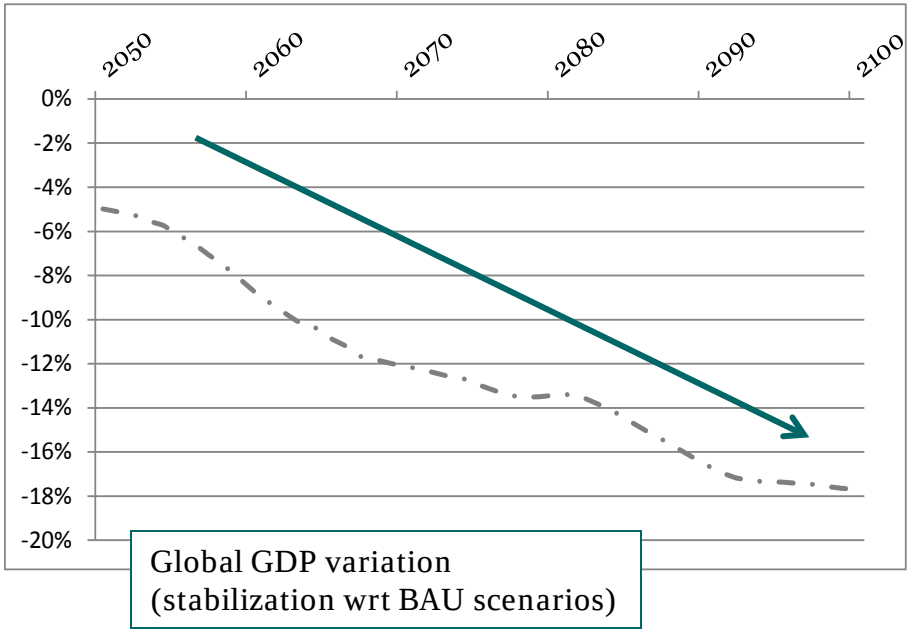
- Less vulnerability to oil price increase
- Reduction of the oil economies dependences

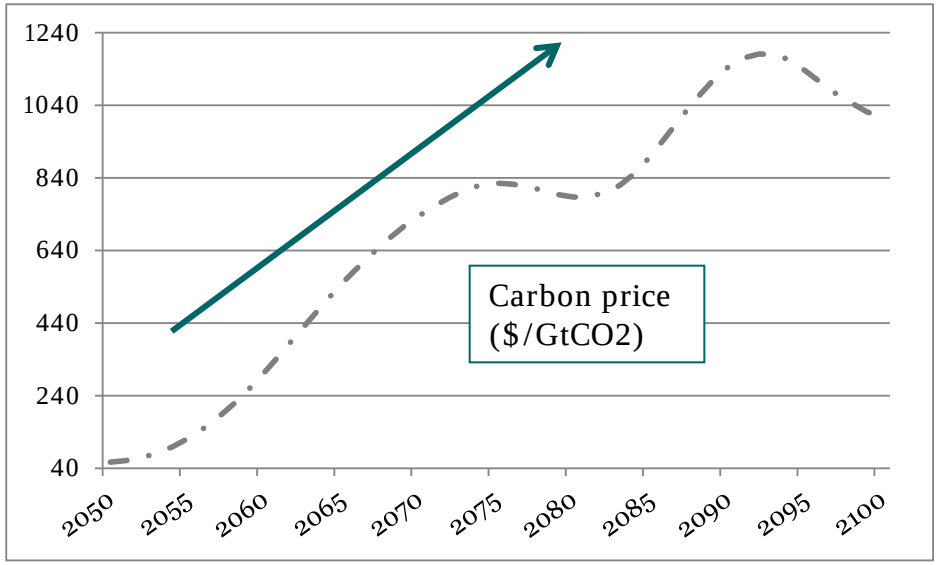
⇔

Correction of the BAU sub-optimalities

Sufficient level ….
……to reach most mitigation potential in the residential, industrial and power sectors

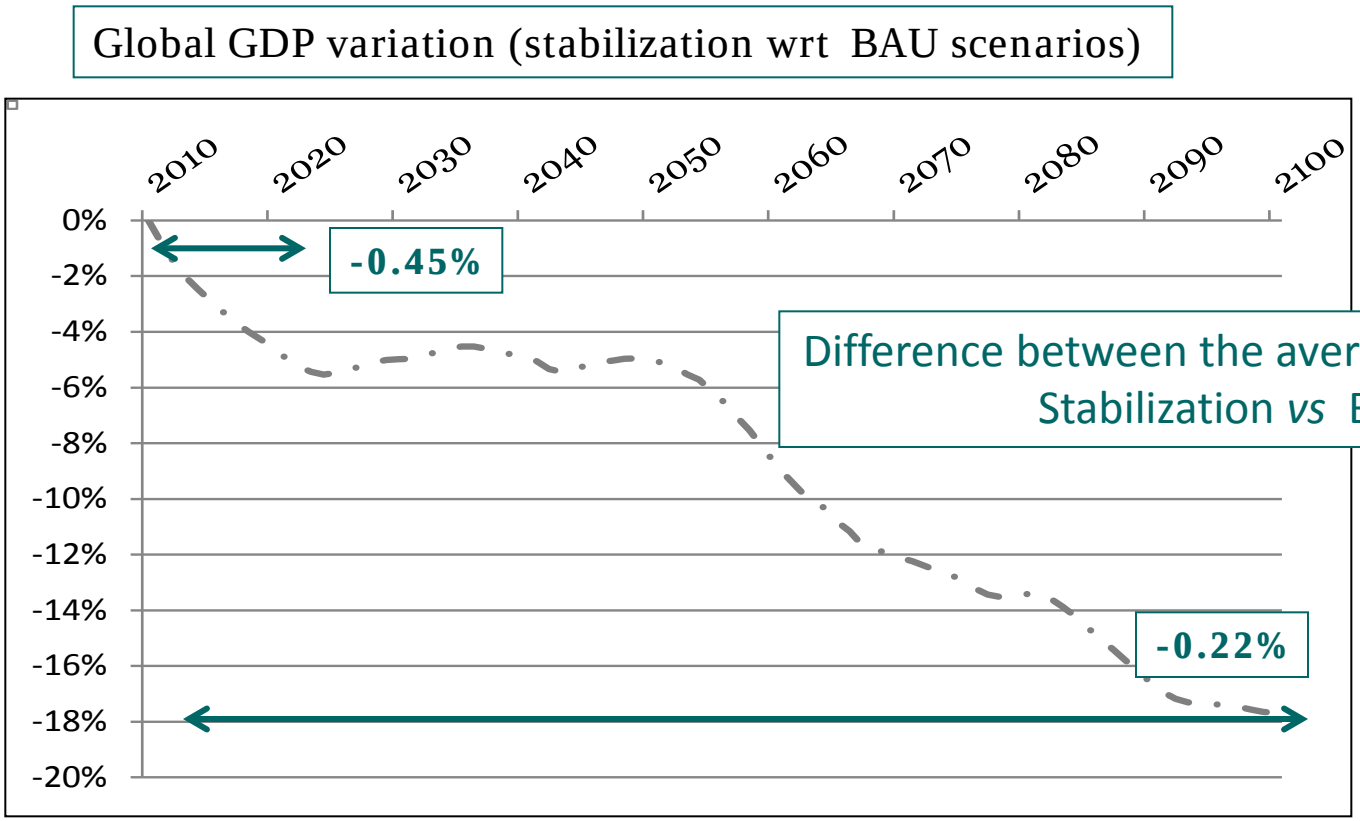
Mitigation costs
Long term





A fast increase of Carbon prices….
Necessary to ensure emission reduction in the transport sector

Mitigation costs
Short term vs Long term



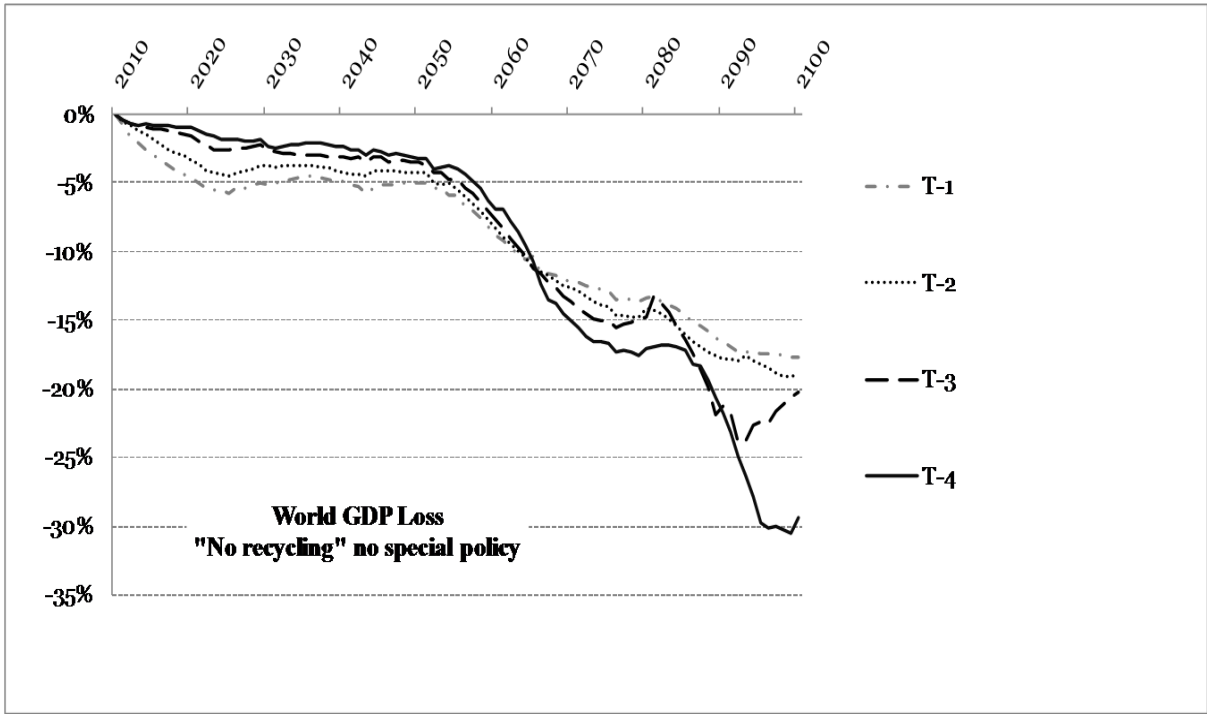
Can we reduce high short term costs? …

What about the dependency on the time profile of emission reductions ?

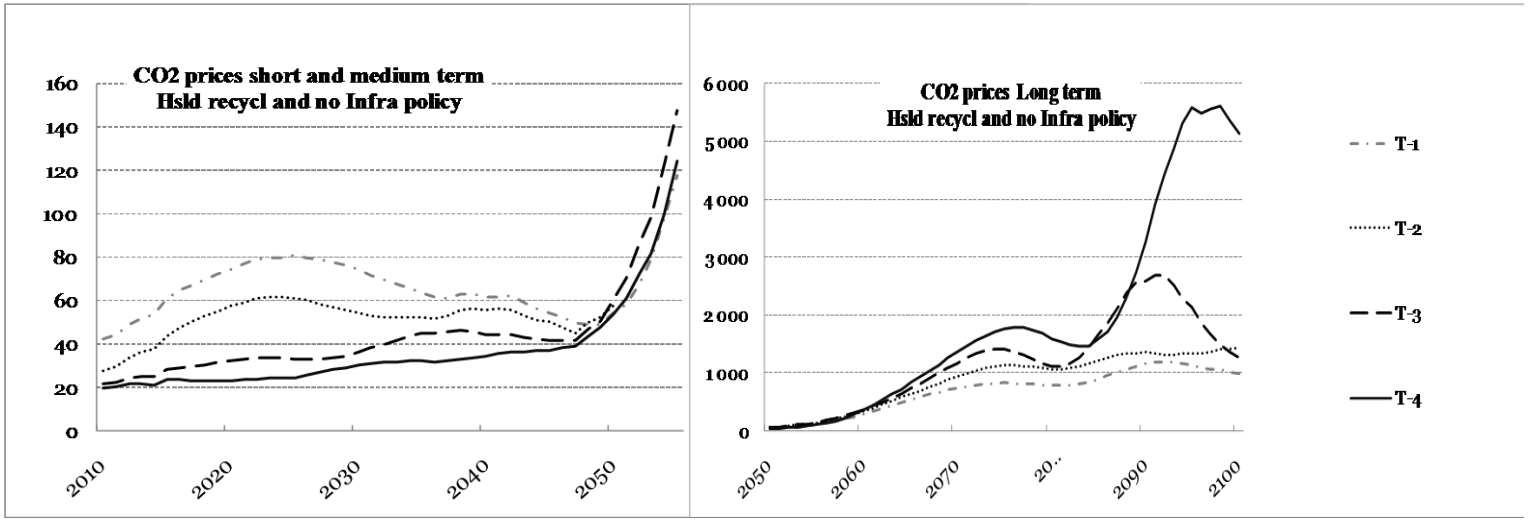
Mean annual growth of the energy efficiency in the baseline scenario

	World	USA	Europe	Chine	Inde
mean annual growth (2001-2100)	1.7%	1.2%	1.90%	2.8%	2.9%
mean annual growth (2010-2050)	2.1%	0.9%	2.10%	3.7%	3.8%
mean annual growth (2010-2100)	1.9%	1.3%	2.00%	2.7%	2.9%

Global GDP variations between stabilization and reference scenarios

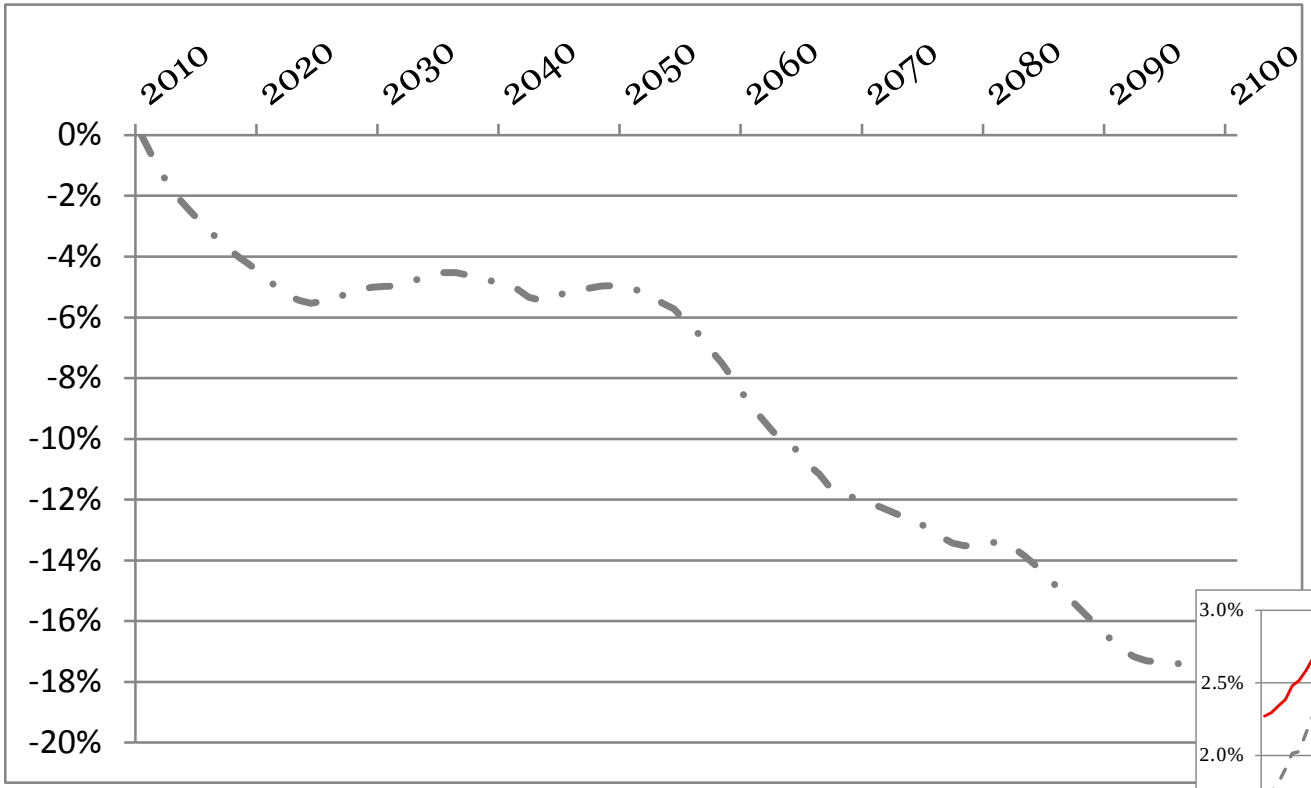


Carbon tax

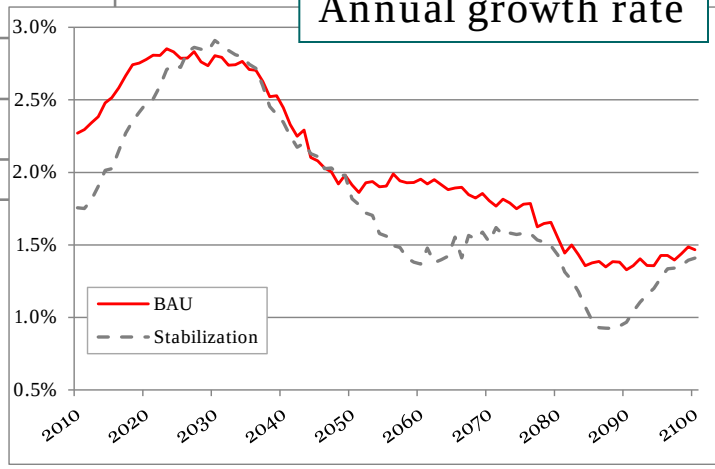

CO2 prices short and medium term
Hsld recycl and no Infra policy
160
140
120
100
80
60
40
20
0
2010
2020
2030
2040
2050
CO2 prices Long term
Hsld recycl and no Infra policy
6 000
5 000
4 000
3 000
2 000
1 000
0
2050
2060
2070
20..
2090
2100
T-1
T-2
T-3
T-4

Mitigation costs

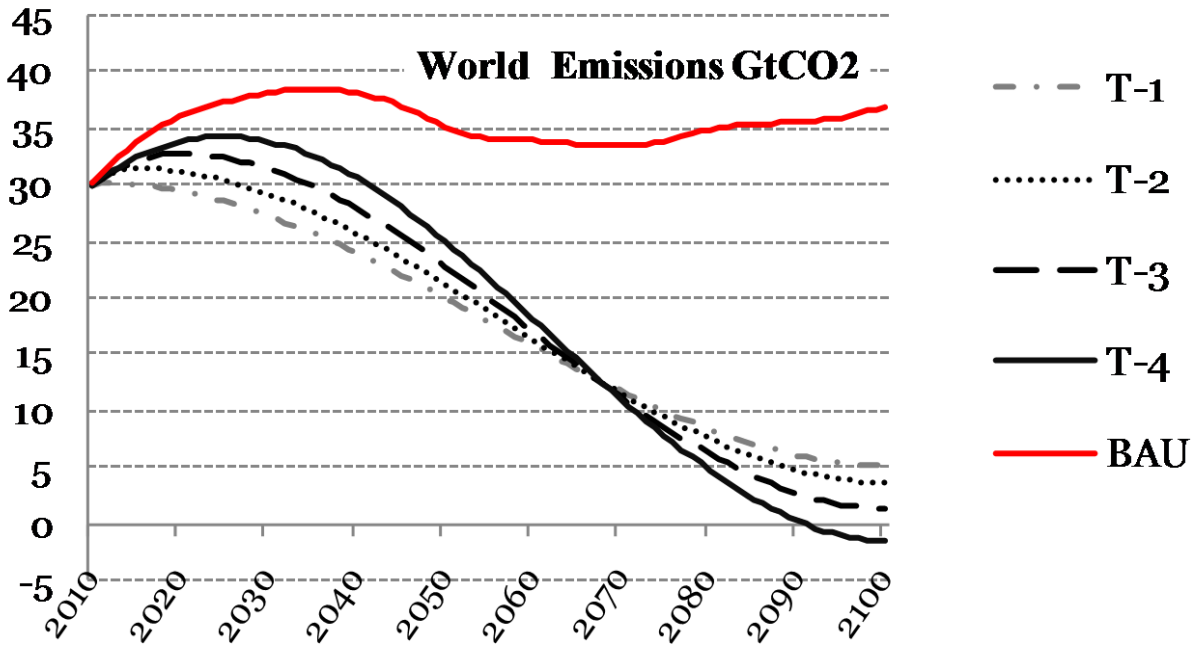
Global GDP variation between climate and reference scenarios



Annual growth rate



Mitigation costs & the timing of emissions reductions



Early action vs Delayed action

A family of 4 trajectories, which differ in terms of:

- date of and level of the emission peak
- LT stabilization level

→ All lead to the same radiative forcing in 2100: 3.4W/m2 in 2100

→ (climate module)

The most important mitigation efforts have to be done at the beginning of the period
vs
The mitigation efforts are concentrated at the end of the period

Early action on long-lived infrastructures

(i) a shift in the modal structure of investment in transportation infrastructure favoring public modes against private cars. Instead of assuming that the allocation of investments follows modal mobility demand, we consider public policies that reallocate part of them from road to low-carbon transportation infrastructure (rail and water for freight transport, rail and non-motorized modes for passenger transport).

(i) a progressive relocation of buildings infrastructure that allows for a reduction of households' constrained mobility (essentially commuting) from the 50% of total mobility as previously considered to 40% .

(i) changes in the production/distribution processes allowing to reduce transport needs (we considered a 1% decrease of the input-output coefficient between transport and industry to be compared with a constant coefficient in the previous case).