CENTRE INTERNATIONAL DE RECHERCHE SUR L'ENVIRONNEMENT ET LE DÉVELOPPEMENT

C.I.R.E.D.

Chaire Modélisation prospective
au service du développement durable

The costs of a global climate agreement for China

A tale of carbon price, "when flexibility" and quota allocation

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Motivation

- The International climate governance/ Post Kyoto framework:

  a lot of uncertainties still remain about future international climate policy architecture.
- The major challenge is to gain compliance of major emerging countries while respecting the "*common but differentiated responsibility*" principle acknowledged in Article 3 of the UNFCCC
- China is a key player in climate negotiations: first CO_2 emitter, very carbon-intensive and fast growth economy
- Standard approach for assessing the costs of climate policies: first best framework

  Optimal functioning of the economy and Optimal emission trajectory

BUT:

- Economic interactions have a second best nature where inertias and imperfect foresights drive economic dynamics away from its optimal trajectories
- Time profile of emission reduction will result from a political decision that may depart from economic optimization

Motivation

We visit the question of the Chinese mitigation costs by considering:

- The emission objective as an exogenous constraint on the economy
- A second best modeling framework

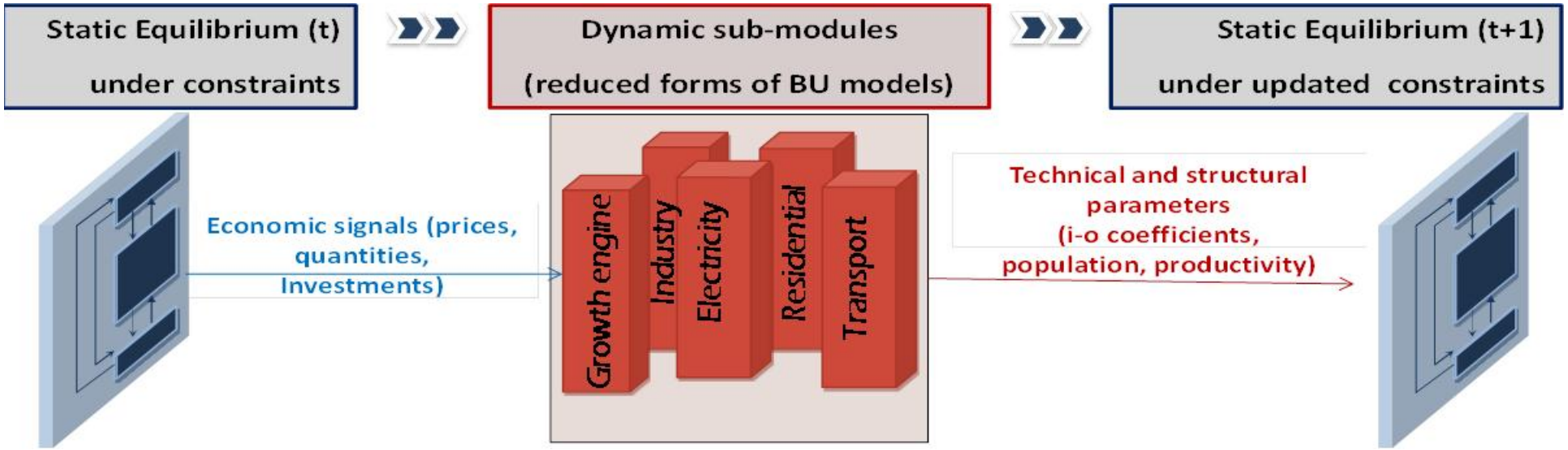
We consider different policy design based on a uniform global carbon price that vary according to :

(i) The temporal profile of carbon emissions reductions

(ii) The quota allocation scheme

The Imaclim-R model

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

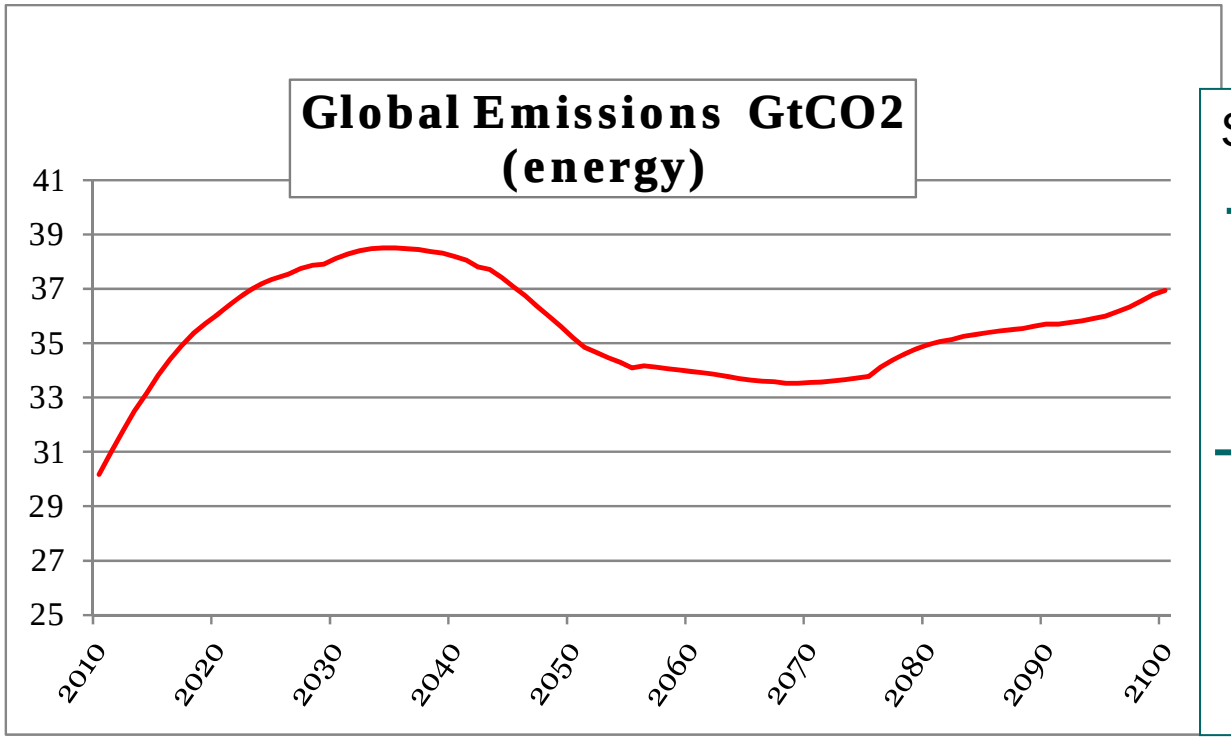


- Hybrid matrix: consistency between money and physical quantities (Calibrated on GTAP & IEA energy balances)
- **Annual time step, recursive succession of :**
  - **Static equilibria: second best economy**

    → **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 global growth rate ~2%

(3% for China)

→ Large diffusion of Energy Efficiency ~2% global increase in av.

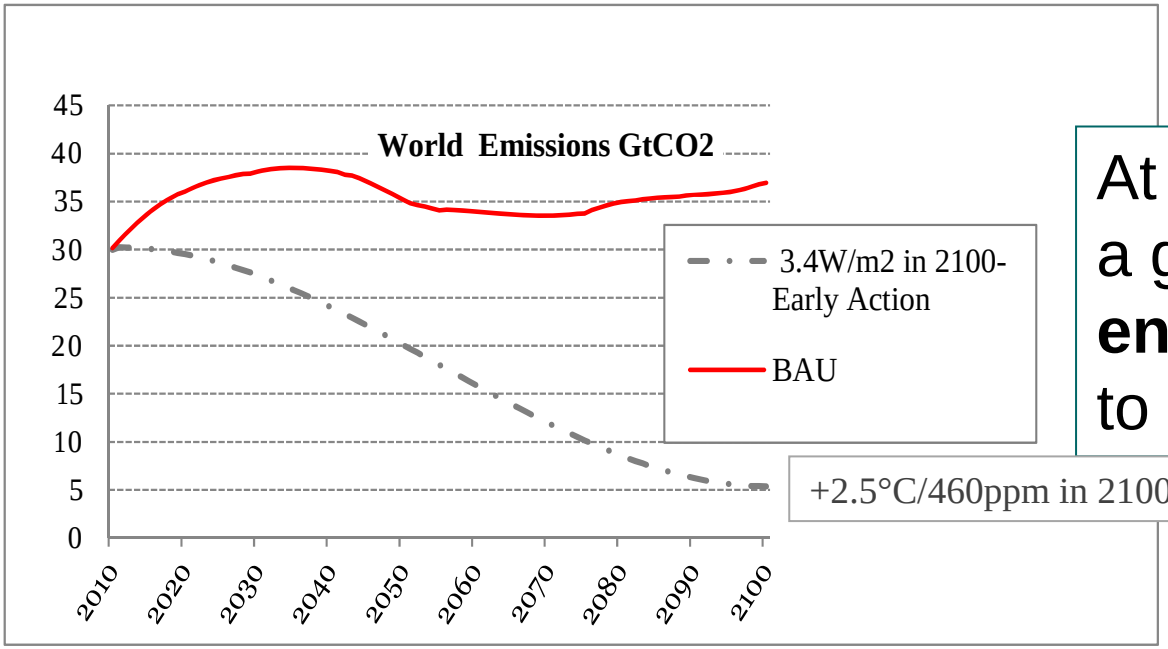
(3% for China)

Lower class of the SRES and post-SRES emissions range

→ Total carbon budget = 946 GtC

Climate policy scenario (benchmark)

Given a **prescribed** CO2 emission objective

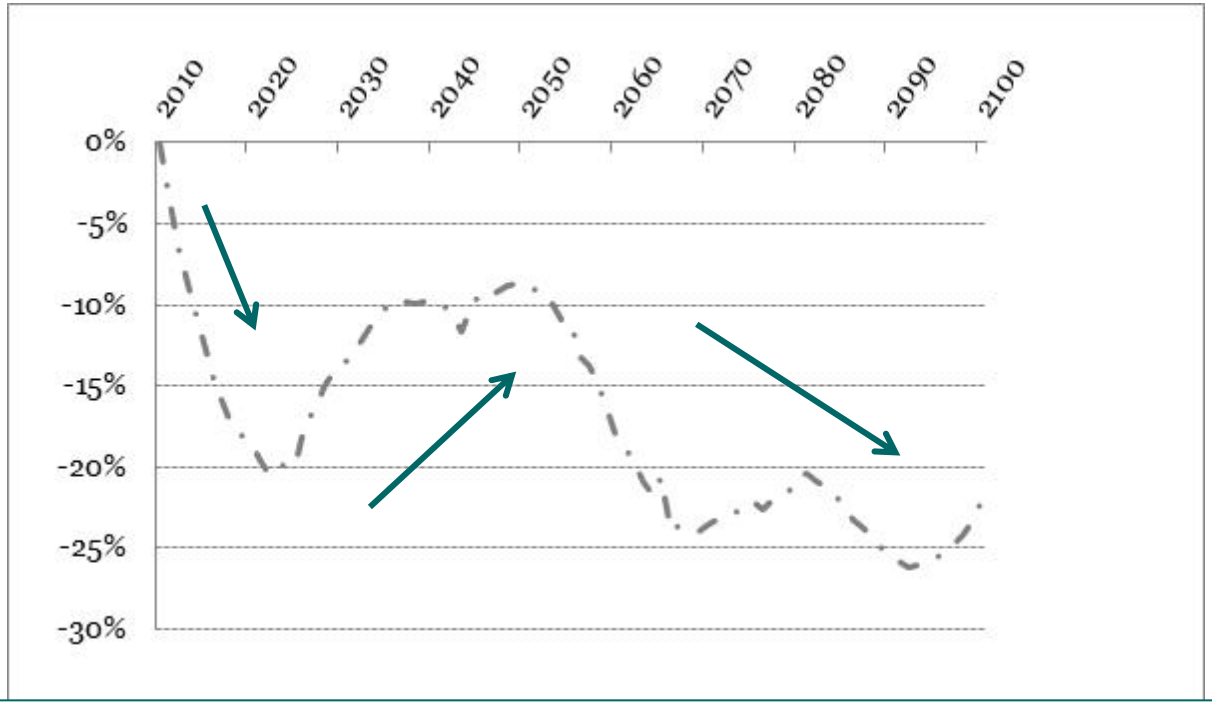


At each date,
a global **carbon price** is **endogenously calculated** to curve carbon emissions

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

Chinese mitigation costs

GDP variation between climate and reference scenarios



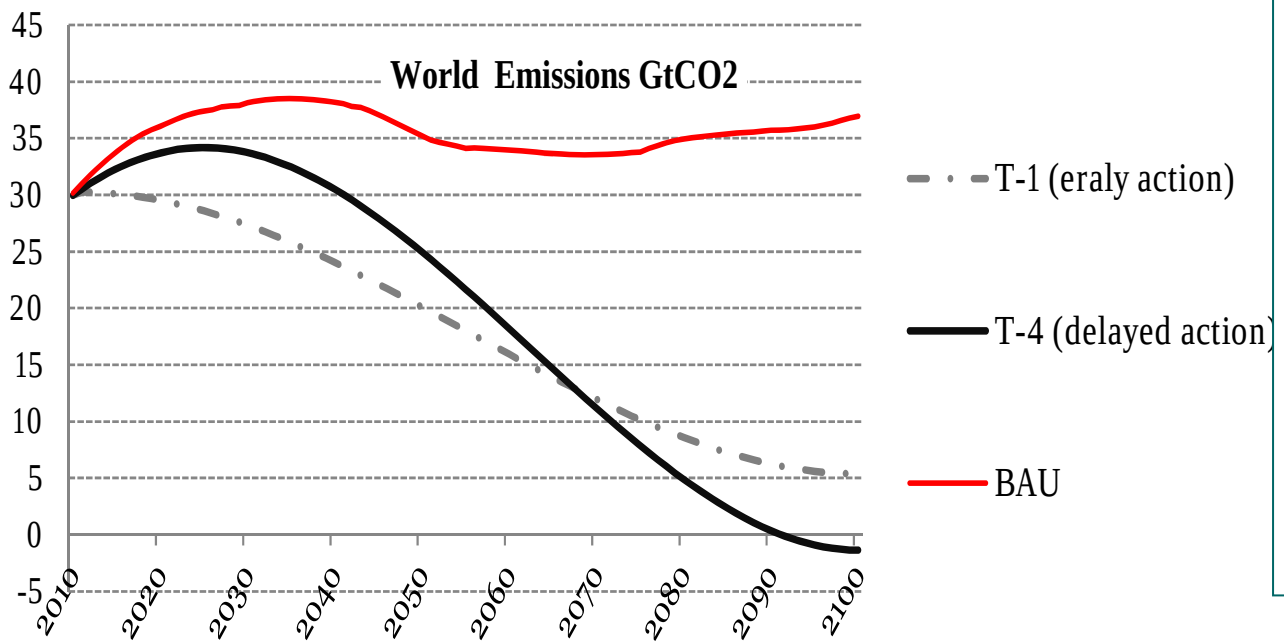
- **Short term**: Imperfect expectations + Inertia → High carbon price
  (redirection of investments)
  High production costs
  (increase of the energy-to-labor costs ratio)
- **Medium term**: Decrease of the carbon price
  Mitigation potential in residential, industrial and power sectors
- **Long term** : Transport infrastructure inertia + High mobility needs → High carbon prices

Chinese mitigation costs of an early global action

- The importance of the consequences of an early global mitigation action in a second-best economy
- The generated global CO2 price induces significant Chinese costs, particularly on the short-term
- Transition costs are a significant issue, they can create high social and political obstacles for implementing a climate policy
- This raises the question of how to reduce them, in particular to be more in line with the "*common but differentiated responsibilities*" principle while respecting the same climate objective

➔ What are the consequences of delaying the global mitigation action on the Chinese economy (given the same climate constraint) ?

Chinese mitigation costs & the timing of global emissions reductions



Two carbon trajectories:

•differ in terms of date of and level of the emission peak

•Both lead to the same climate objective in 2100 (3.4W/m², +2.5°C, 460ppm)

→(same climate module)

Early action vs Delayed action

Chinese mitigation costs & the timing of global emissions reductions

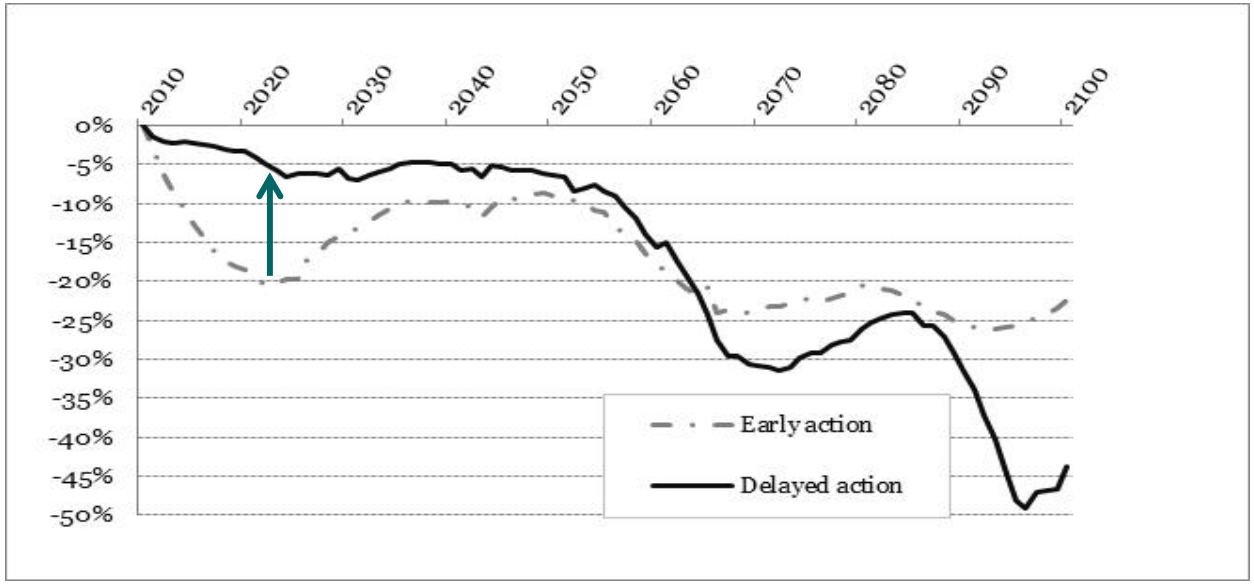
For China, delaying the global mitigation efforts is more in line with the "*common but differentiated responsibilities*" principle:

In the short and medium term, the share of the Chinese mitigation efforts in the global effort is lower in the "*delayed action*" scenario than in the "*early action*" one

(e.g. in 2025, Chinese carbon emissions represent 28% of the global emission constraint when the mitigation action is delayed while they represent 23% in the "early action" scenario)

Chinese mitigation costs early vs. delayed action

GDP variation between climate and reference scenarios



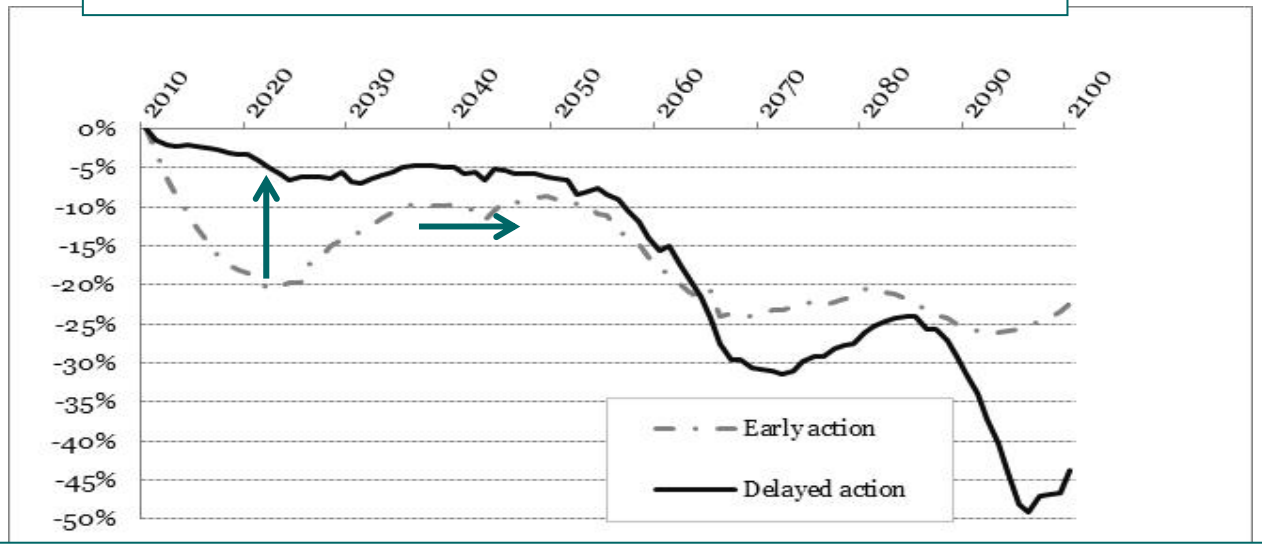
➢ **Short-term**:

Postponing the decarbonization efforts improves the economic situation

→ Global mitigation efforts are divided by three
- → Lower carbon price (*e.g.* 25$/tCO2 *vs* 80$/tCO2 in 2025)
- → Chinese economy is less affected.

Chinese mitigation costs
early vs. delayed action

GDP variation between climate and reference scenarios



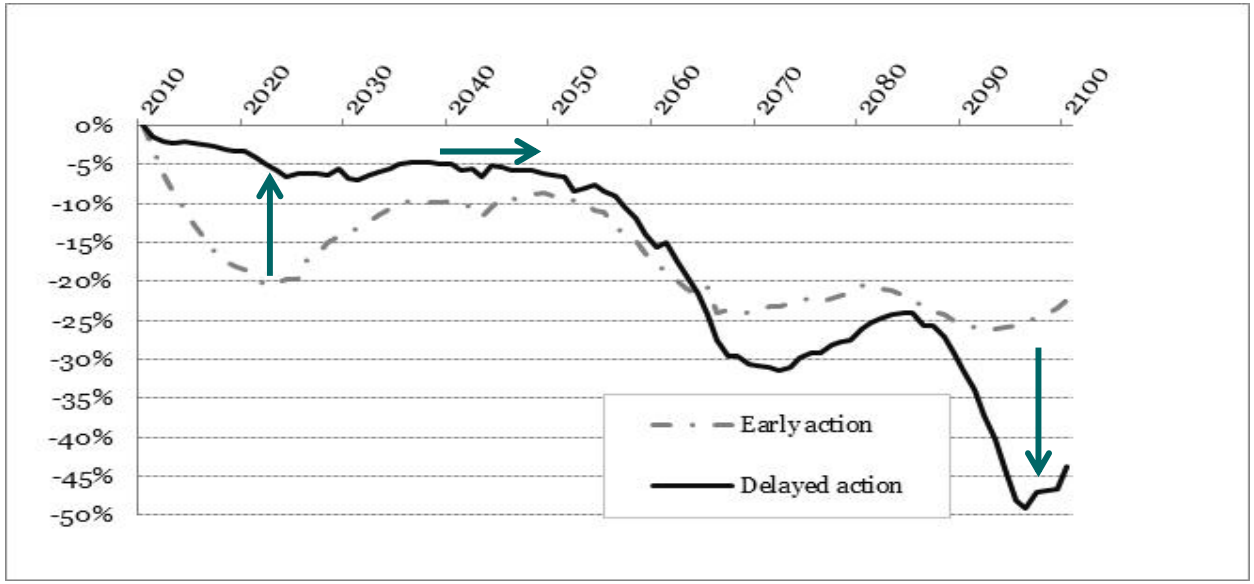
- **Medium-term**:

  The global mitigation constraint continue to be lower
  Carbon price remains lower
  The Chinese economy is still doing better
  But
  The speed of the learning-by-doing in low carbon technologies is less important
  A less important decarbonization of the Chinese economy
  (China continue to develop production systems relying on fossil fuel energies)

  The economy doesn't observe gains wrt. the baseline but only equal growth rates
  (The catch-up phase is now only a stagnation phase)

Chinese mitigation costs
early vs. delayed action

GDP variation between climate and reference scenarios



- **Long-term**:

→ The transportation issue (infrastructure inertia + high mobility needs) is still relevan
→ The most decabonization efforts have to be done in most of the other sectors
(China suffers from inertias on the installed carbonized capital)
→ Very high carbon prices
→ Much higher GDP losses

Chinese mitigation costs & the timing of global emissions reductions

Finally, we can say that delaying global mitigations efforts allows for significant reductions in the Chinese transition costs, but makes the situation worse on the long term due to inertias limiting the flexibility of adjustments.

Chinese mitigation costs & Quota allocations

Another way to take into account the differentiated responsibilities of the regions in the mitigation action issue, is to consider specific emission burden sharing rules under a global-cap-and-trade agreement

⟶ We have chosen to investigate two stylized rules :

- *a Contraction & Convergence* scheme (Meyer, 2000)
- a *Common but Differentiated Convergence* scheme (Höhne et al., 2006)

The international permit market is modeled by defining regional allocations and introducing money transfers according to the difference between the quotas and actual emissions.
Regions trade allowances with each other at the single global CO_2 price.

Chinese mitigation costs & Quota allocations

- The *Contraction & Convergence* (*C&C*) scheme

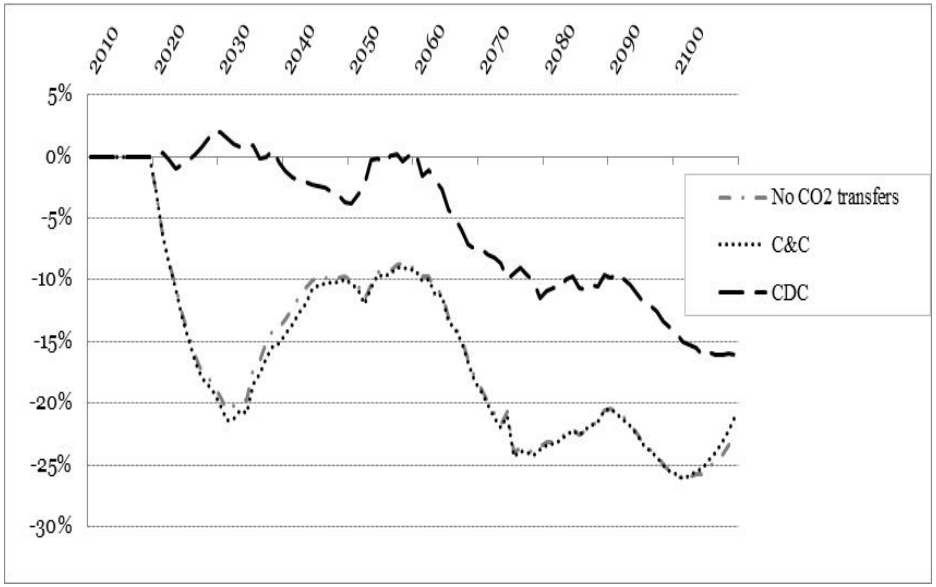
  considers a linear progression of the regional emissions shares from status-quo in 2010 to equal per capita emissions in 2100.

- The *Common but Differentiated Convergence* (*CDC*) scheme

  similar to the *C&C* approach, but in addition to taking populations of each region into account, it considers their historic responsibility.
  Annex-I countries are more constrained than in C&C
  Developing countries are less constrained.
  Annex-I countries' per capita emission allowances converge to equal per capita emissions in 2100.
  Developing countries converge to the same level in 2100 ('common convergence'), but they start entering into the scheme later than Annex-I countries ('differentiated convergence')
  In this paper: Developing countries (incl. China) enters in 2040

Chinese mitigation costs & Quota allocations

GDP variation between climate and reference scenarios

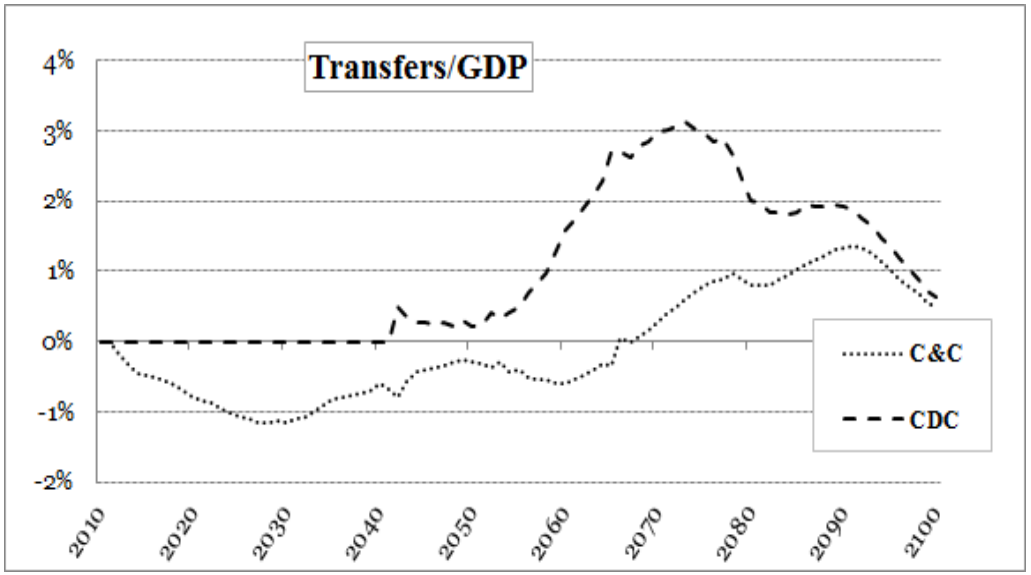


We compare the Chinese mitigation costs under these two schemes to the case where no carbon trade is set of (*No Transfer* scenario)

- C&C :
  Hardly worsens the situation on the short term.
  Doesn't provide any substantial change on the medium and long term

- CDC :
  Improves significantly the situation on the whole period
  ….Gains on the ST

Chinese mitigation costs & Quota allocations



Share of CO2 capital transfers in the Chinese GDP

The improvement of the costs is linked to the sign of carbon money transfers that are operated

- → "+" when China sells permits
- → "- " when it buys permits

In C&C scheme:

The amounts of shares are roughly the same than the amount of improvements (>0 or <0) observed on the GDP losses

In CDC scheme:

The amount of improvements is much more important due to the progressive entrance of China in the scheme….(also because AnnexeI supports the burden in the first period!)

Conclusion

- Dealing with the timing of emission reduction induces a time shift of mitigation costs according to the period where most efforts are conducted

→ The issue can be shifted from the short to the long-term, to be in line with the "*common but differentiated responsibilities*" principle, but it appears that the "when flexibility" lever alone is not the solution particularly for an energy intensive country like China, due to the strong inertias limiting the flexibility of adjustments.

But :

- Combining delaying the efforts with an adequate quota allocation scheme is benefic for China….difficult to accept for AnnexI countries…..
- However, Chinese mitigation costs remain important, which suggests the recourse to complementary policies and measures in addition to carbon pricing to help smoothing the necessary shift to a low carbon society

Thank you for your attention!
谢谢

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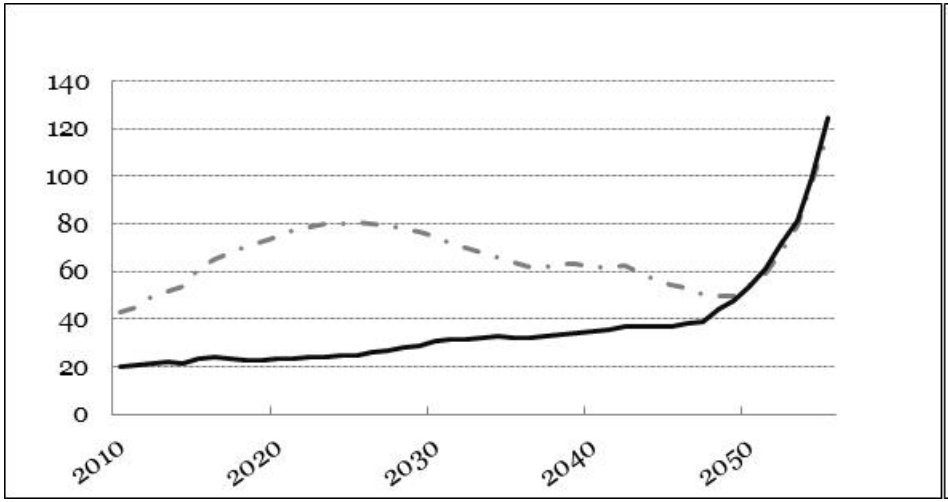
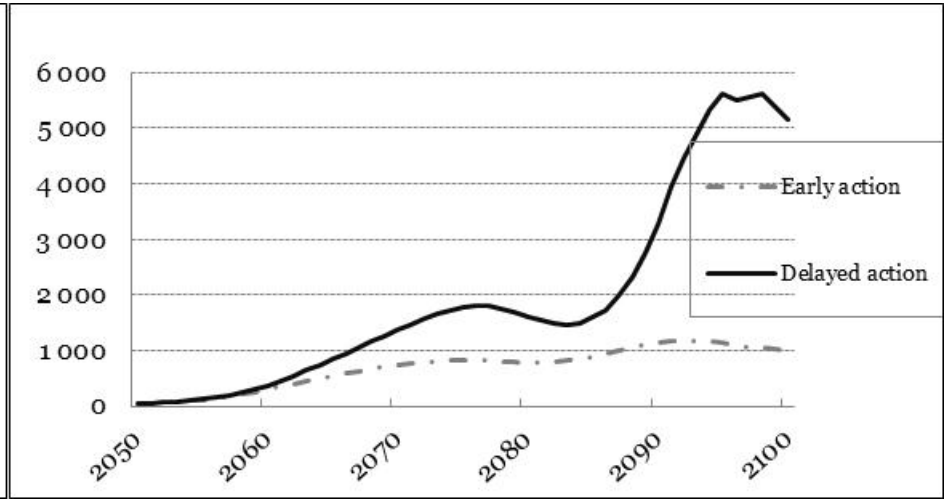
Appendix

Carbon price ($/tCO2)

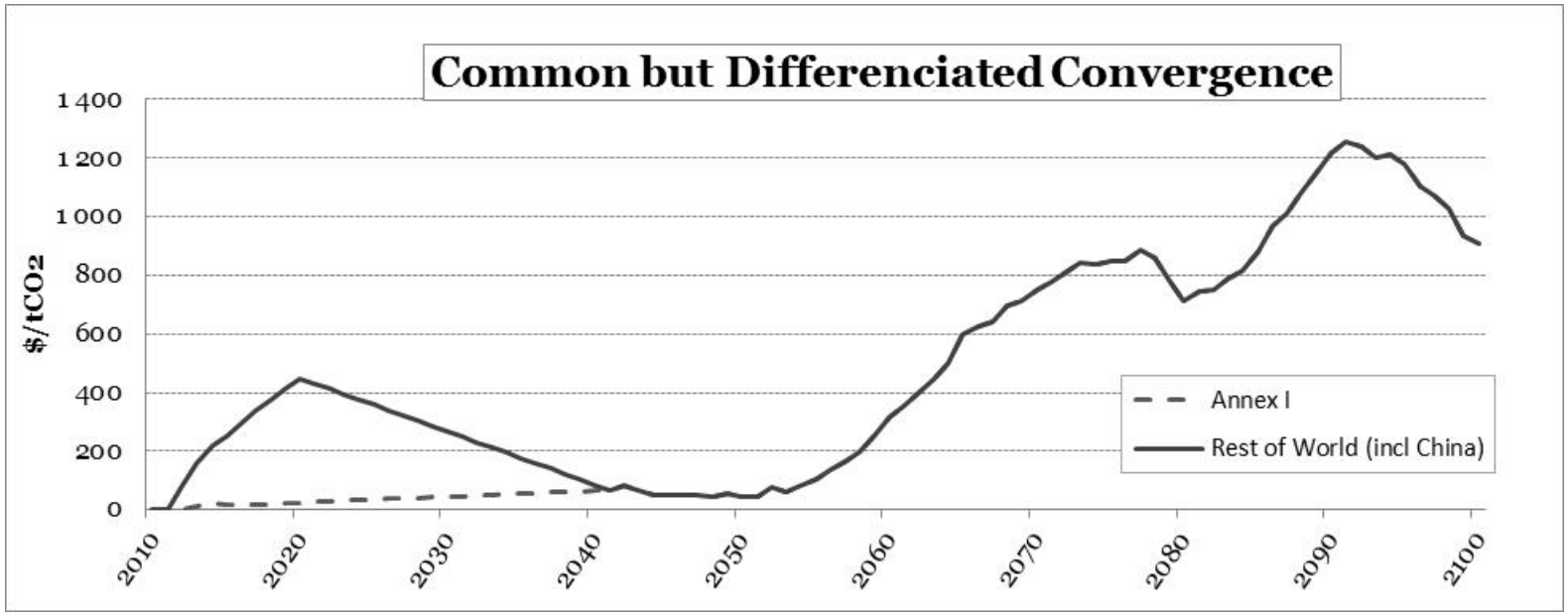


Short and medium term

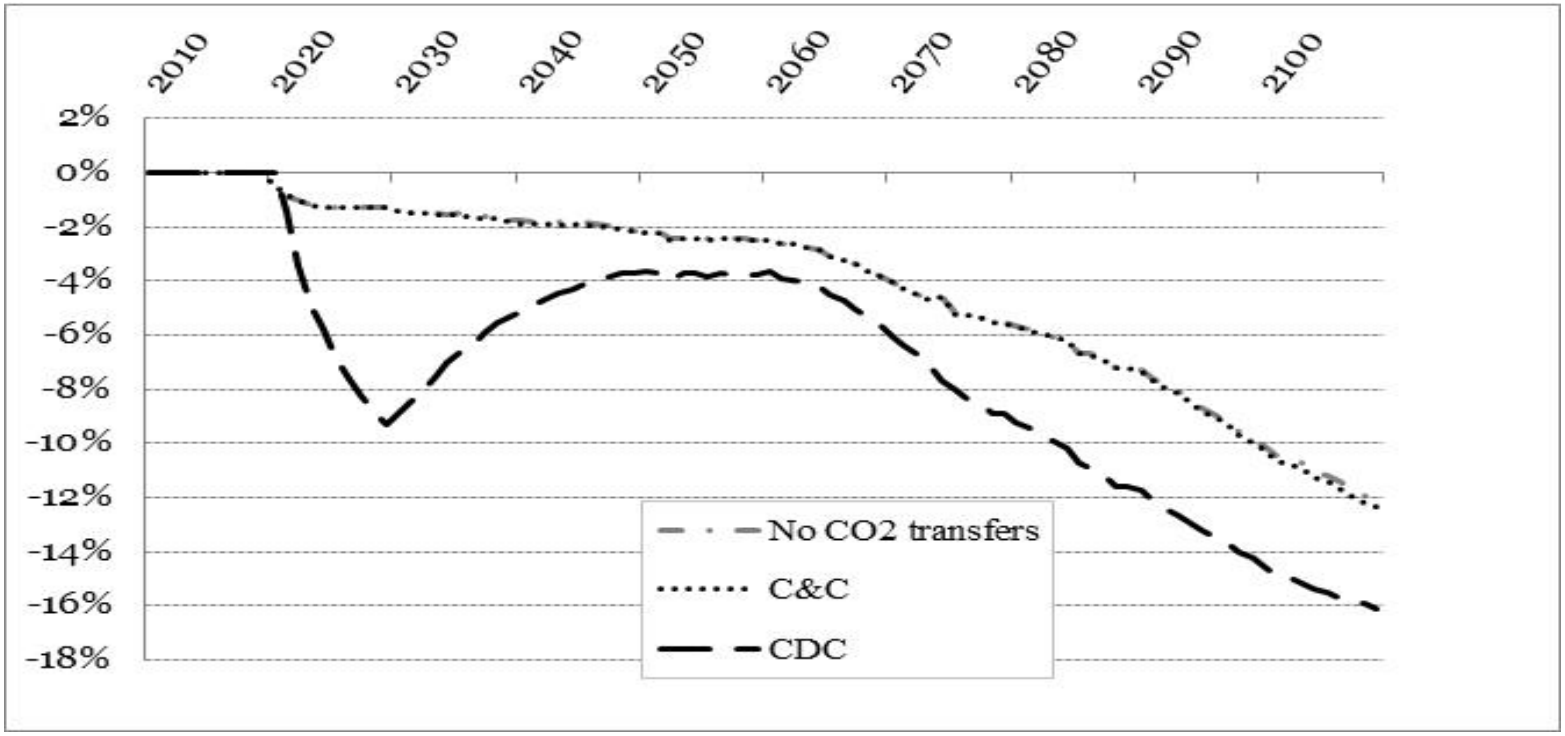


Long-term

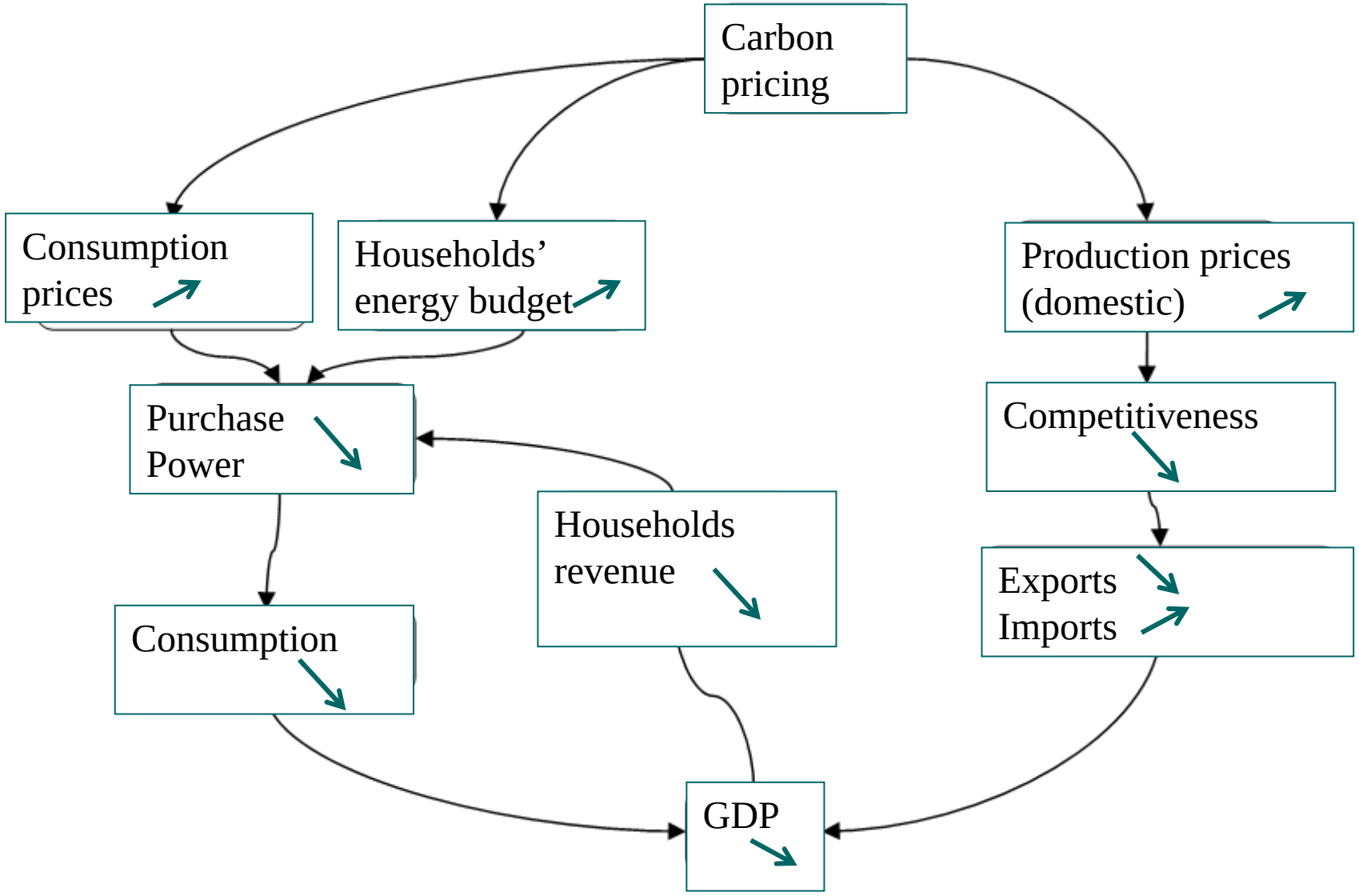
Carbon price ($/tCO2)



Annex I countries GDP losses



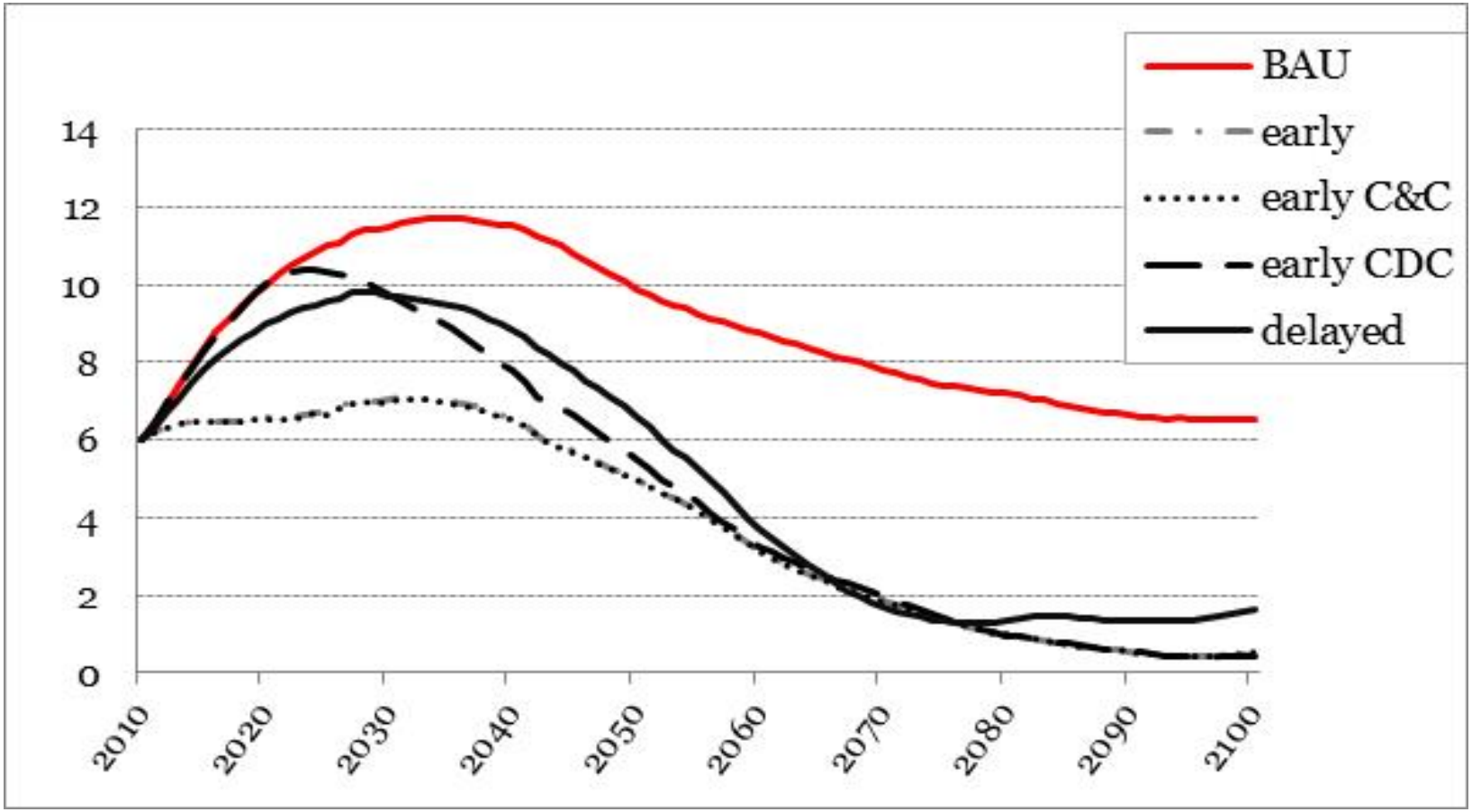
How carbon price acts on the economy



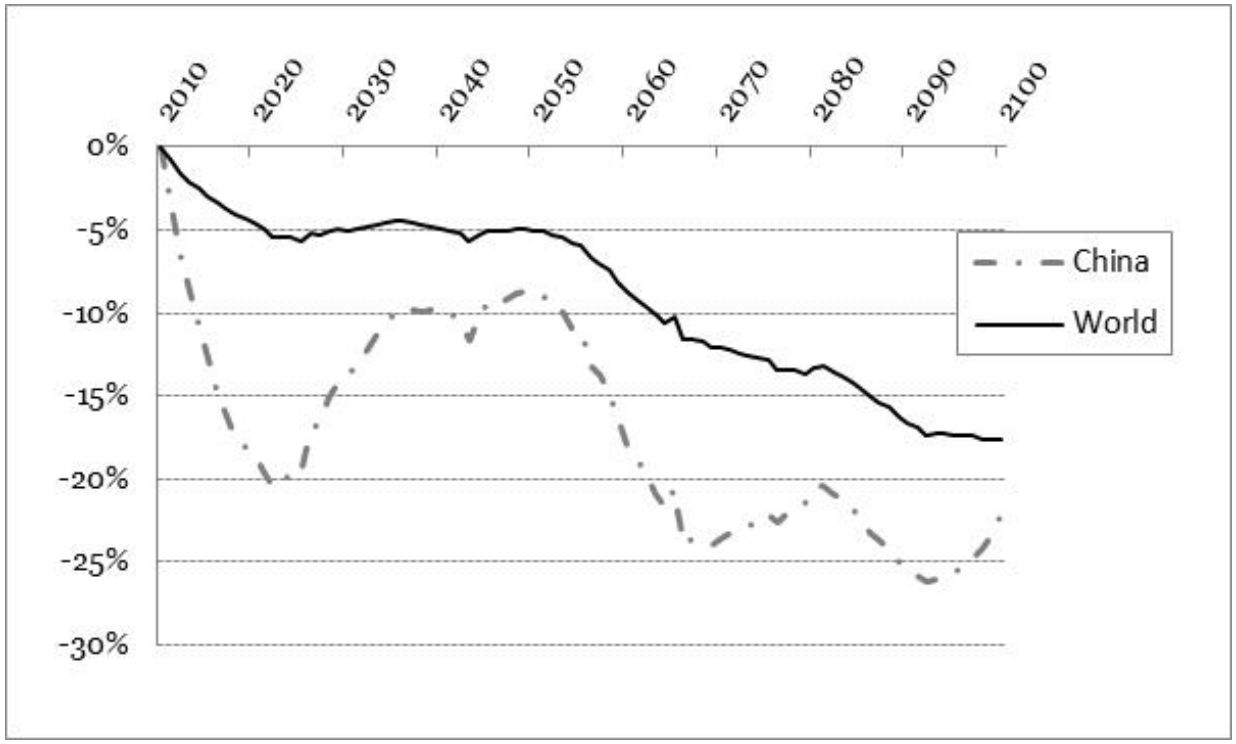
Comment:

Considering the beginning of the global climate policy in 2010 admittedly not realistic, but this should not be a problem since the purpose of the paper is not to simulate reality but rather to give some framing and understanding of the mechanisms at work in order to better understand the reality.

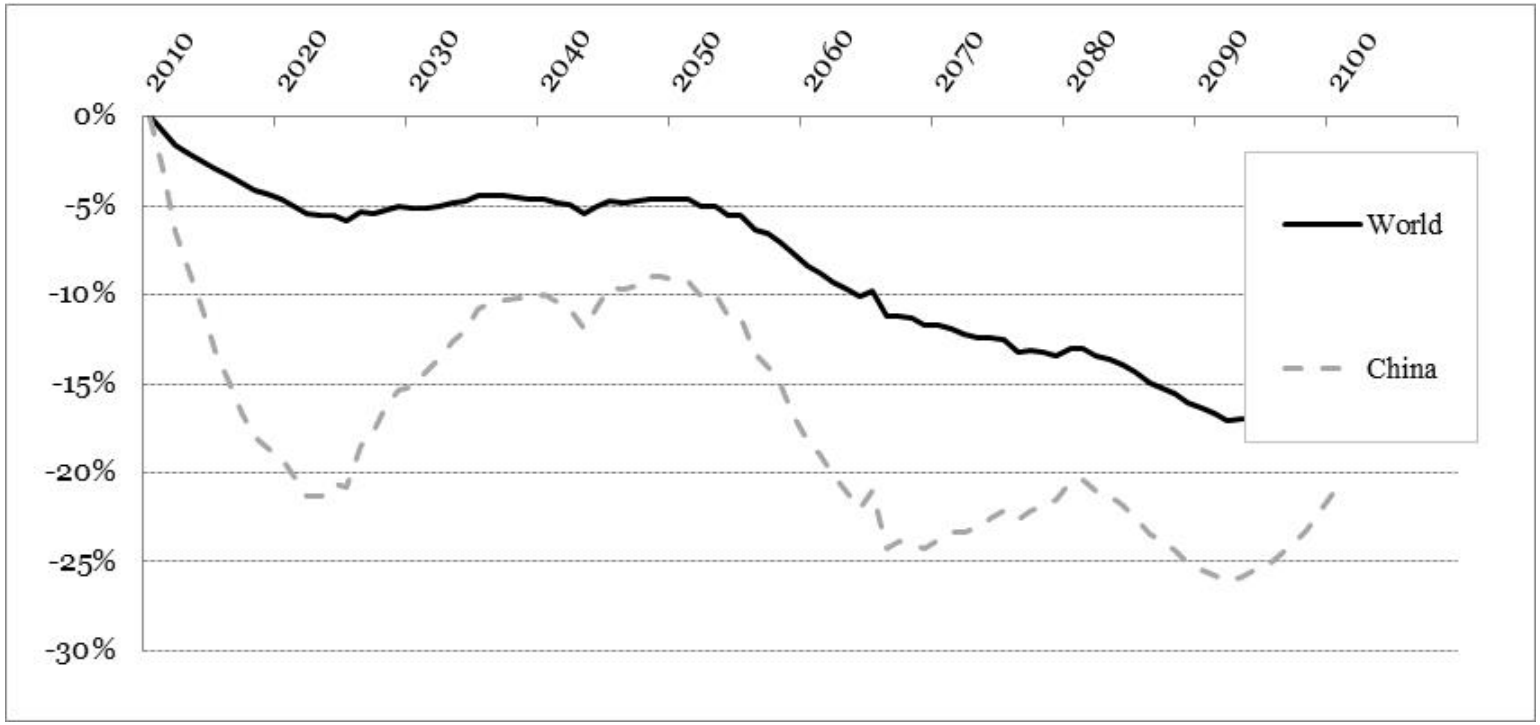
Chinese Carbon emissions (GtCO2)



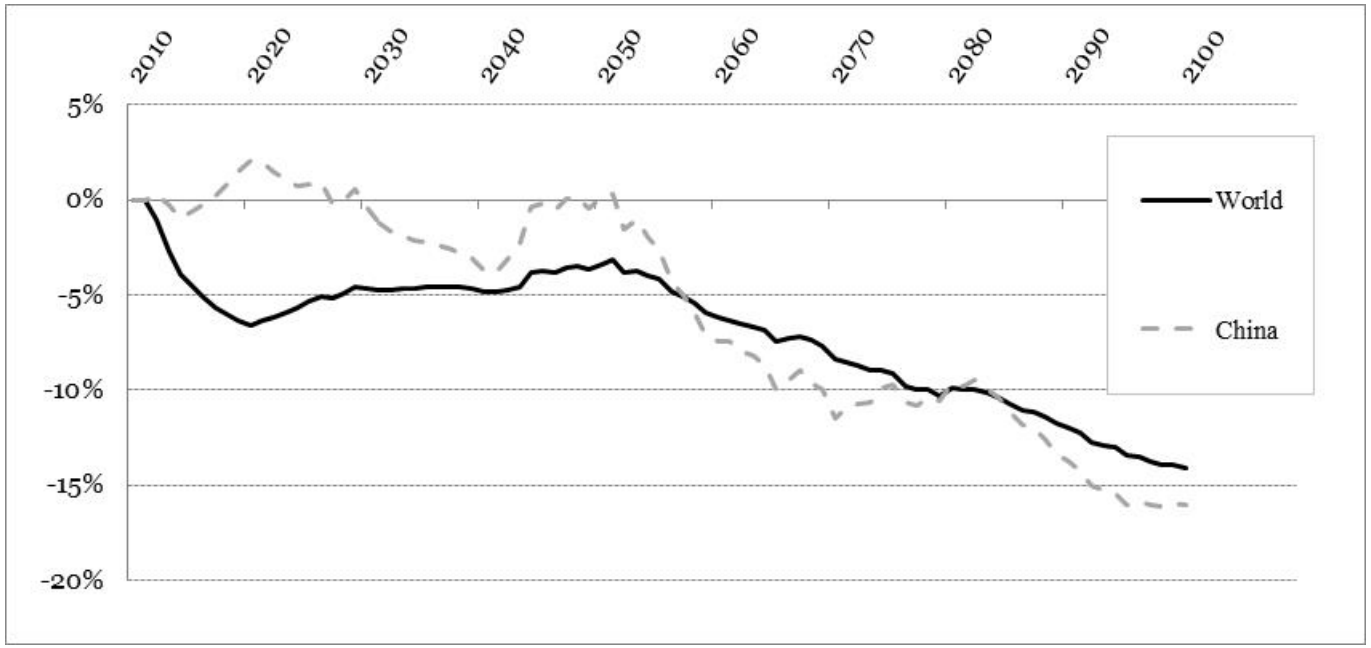
GDP variation between climate and reference scenarios (No Carbon transfer)



GDP variation between climate and reference scenarios (C&C)



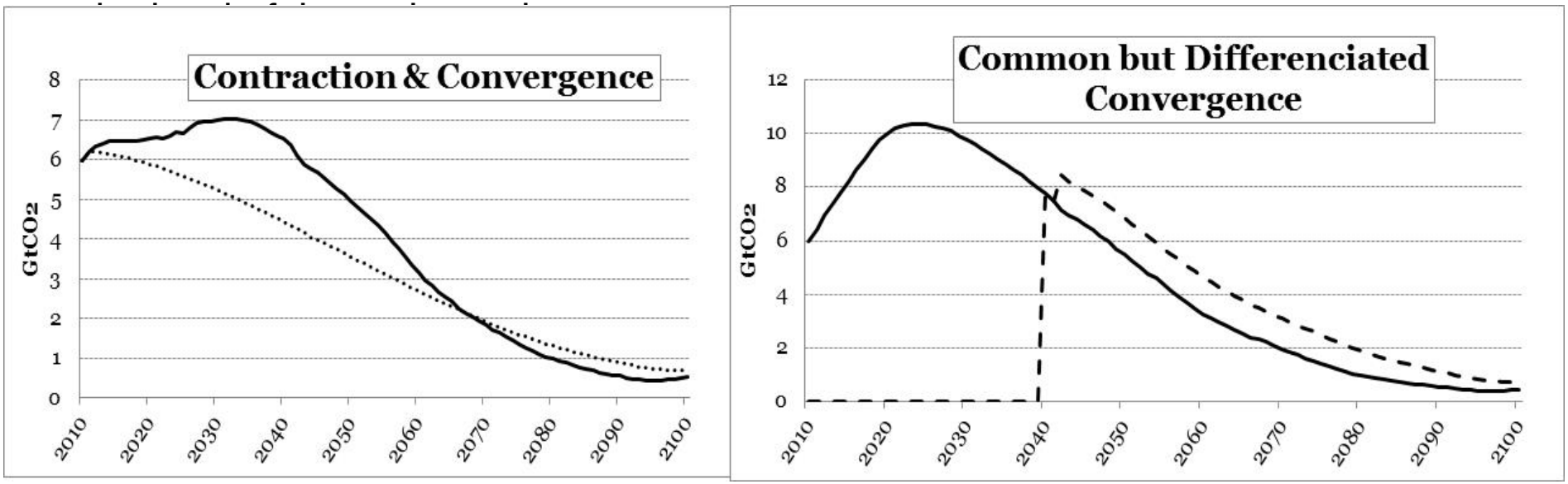
GDP variation between climate and reference scenarios
CDC scheme



Chinese mitigation costs & Quota allocations

The effects (“+” when China sells permits, ”- “ when it byes permits) obviously linked to:

→ the amounts of quotas allocations



Chinese actual emissions (full lines) *vs* quota allocations (dotted lines)

In both scenarios, costs are governed by:

1- **Price effect:** for C&C, even large amount of traded permits, the carbon price is not so high (max 80$/tCO2)

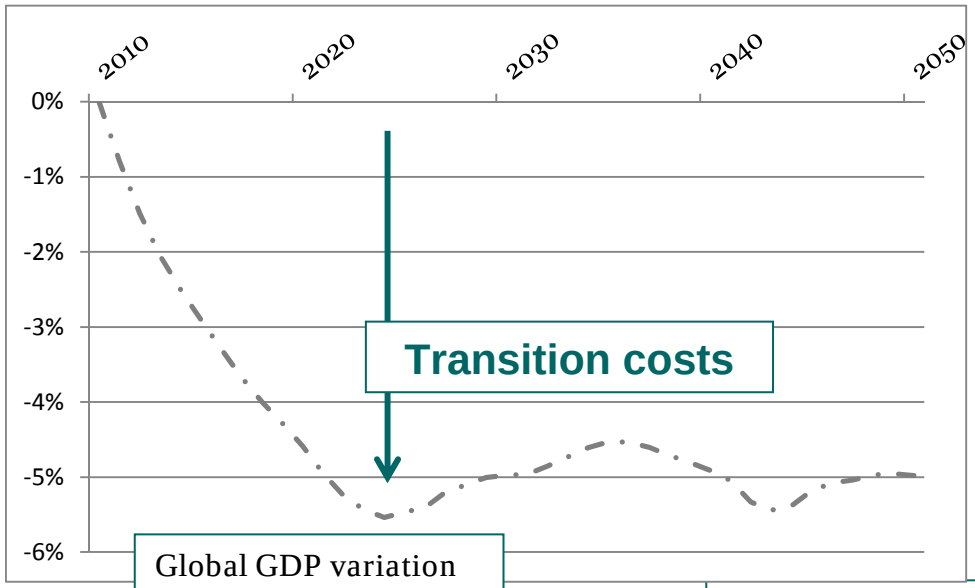
2- **Volume effect:** very high carbon prices, with a small volume of sold permits in C&C, and quite important one in CDC

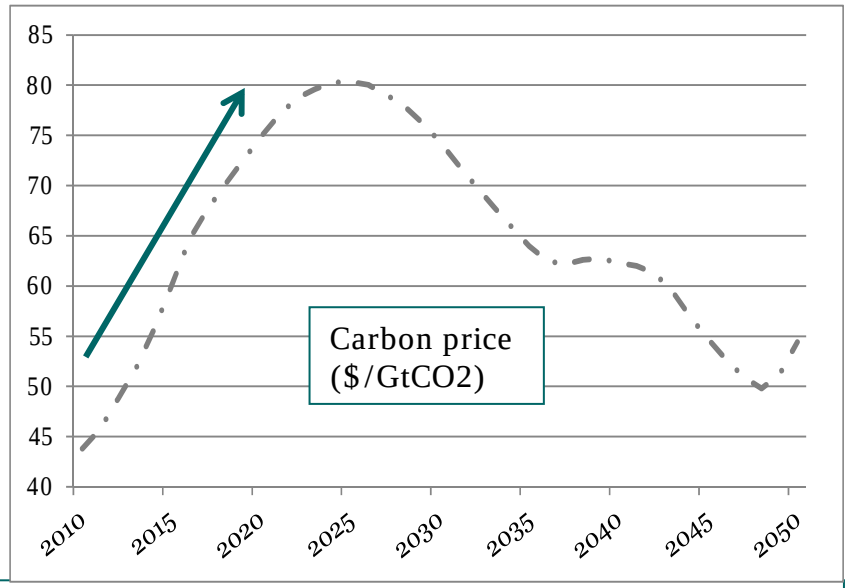
Mean annual growth of the energy efficiency in the baseline scenario

	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 level:

Mitigation costs
Short term





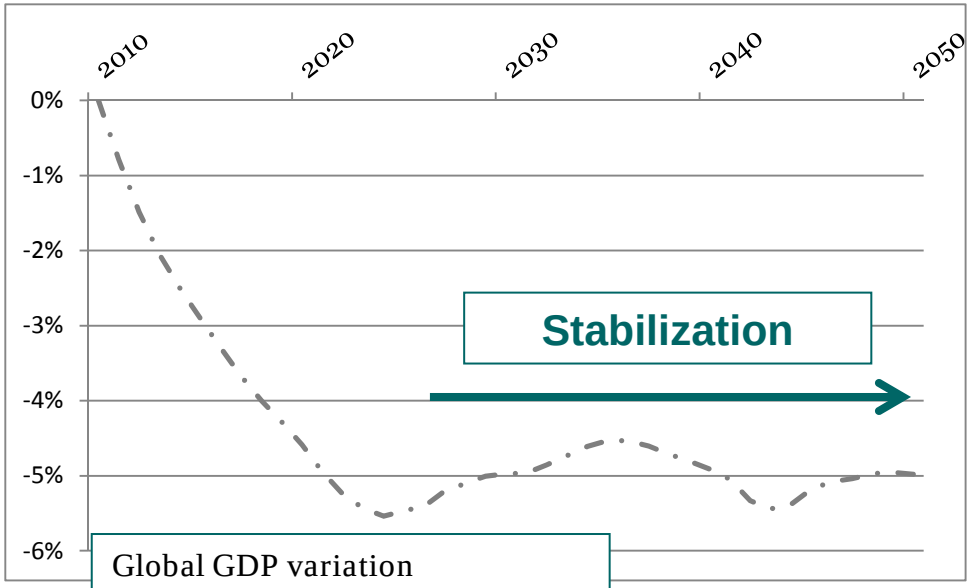
Imperfect expectations
Inertia on installed capital & end-use equipment

→ Only high carbon prices to redirect investments choices

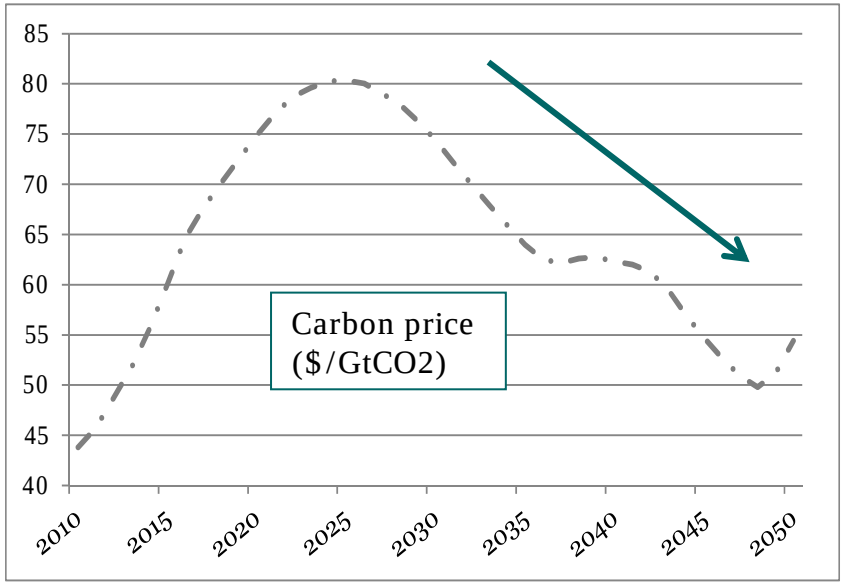
Increase of
- Production costs & Consumption prices
- Unemployment

→ High transition costs

Mitigation costs
Medium term



Global GDP variation
(stabilization wrt BAU scenarios)



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

⇒

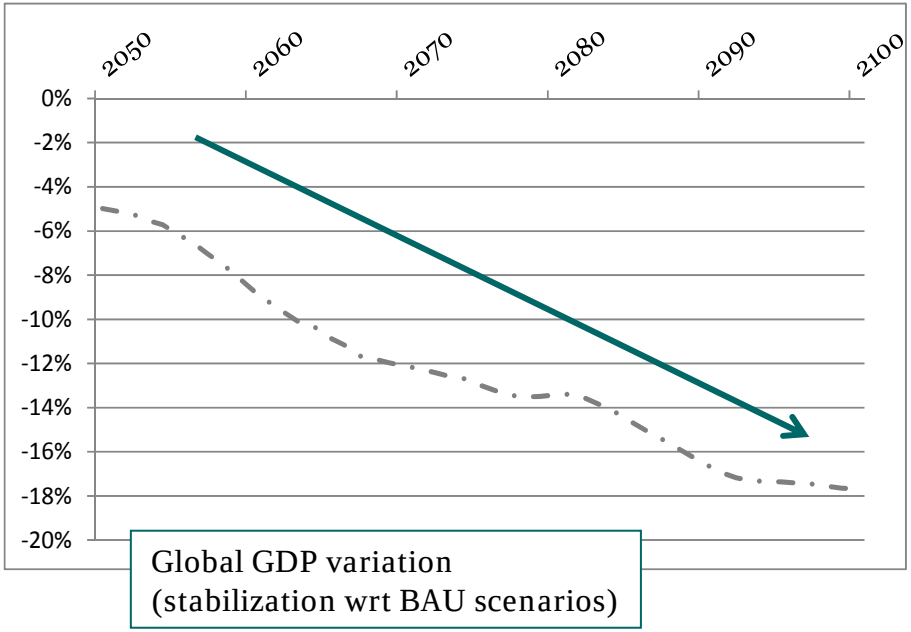
- Less vulnerability to oil price increase
- Reduction of the oil economies dependences

⇔

Correction of the BAU sub-optimalities

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

Mitigation costs
Long term



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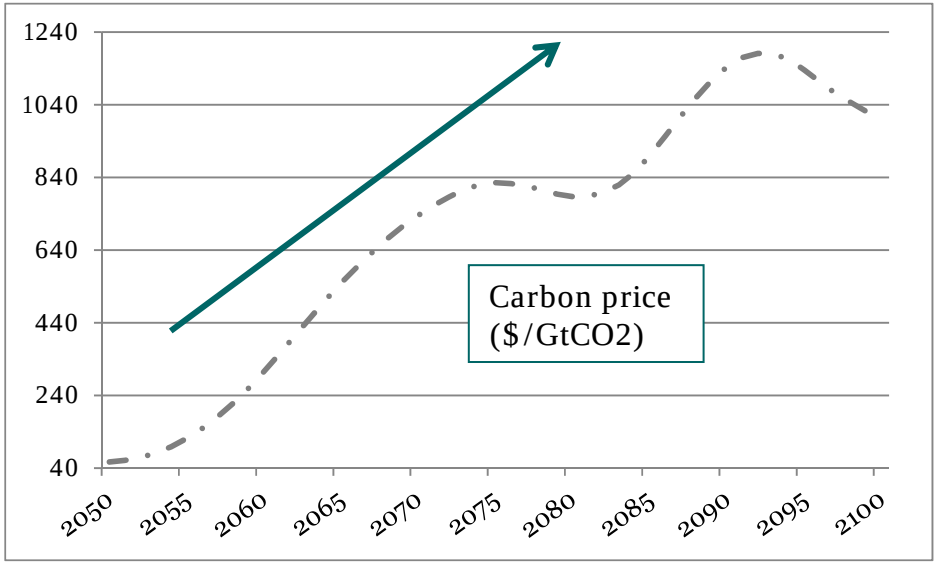
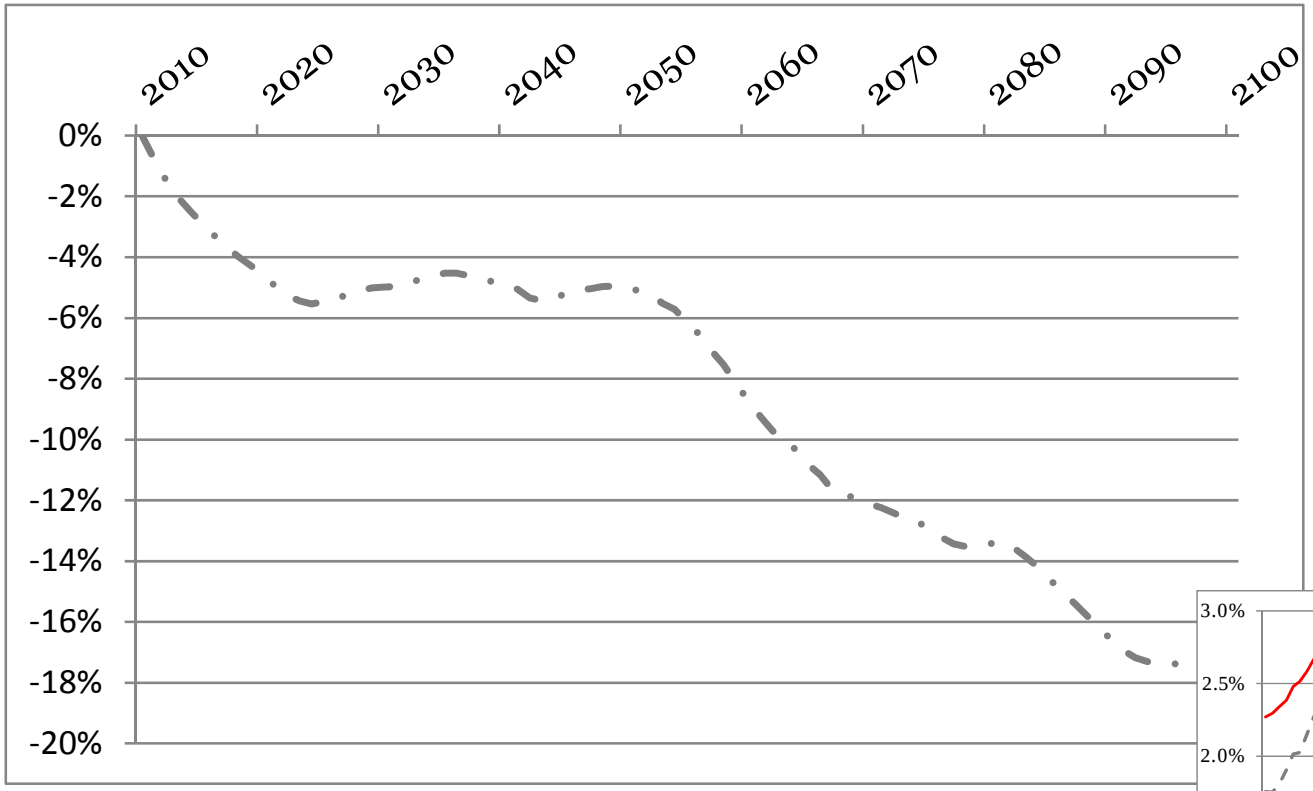


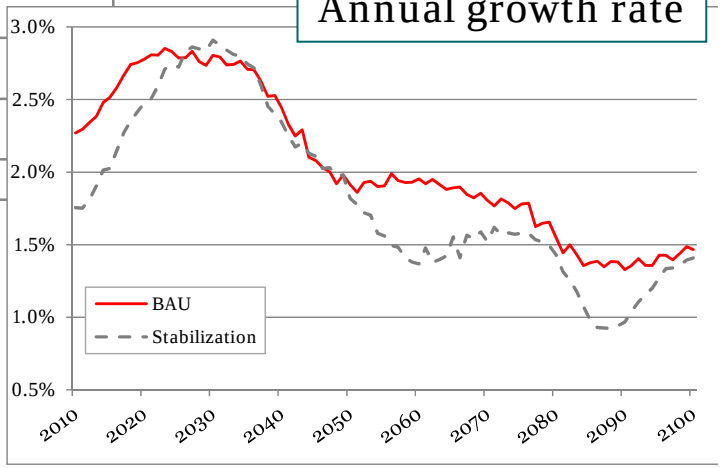
A fast increase of Carbon prices….
Necessary to ensure emission reduction in the transport sector

Mitigation costs

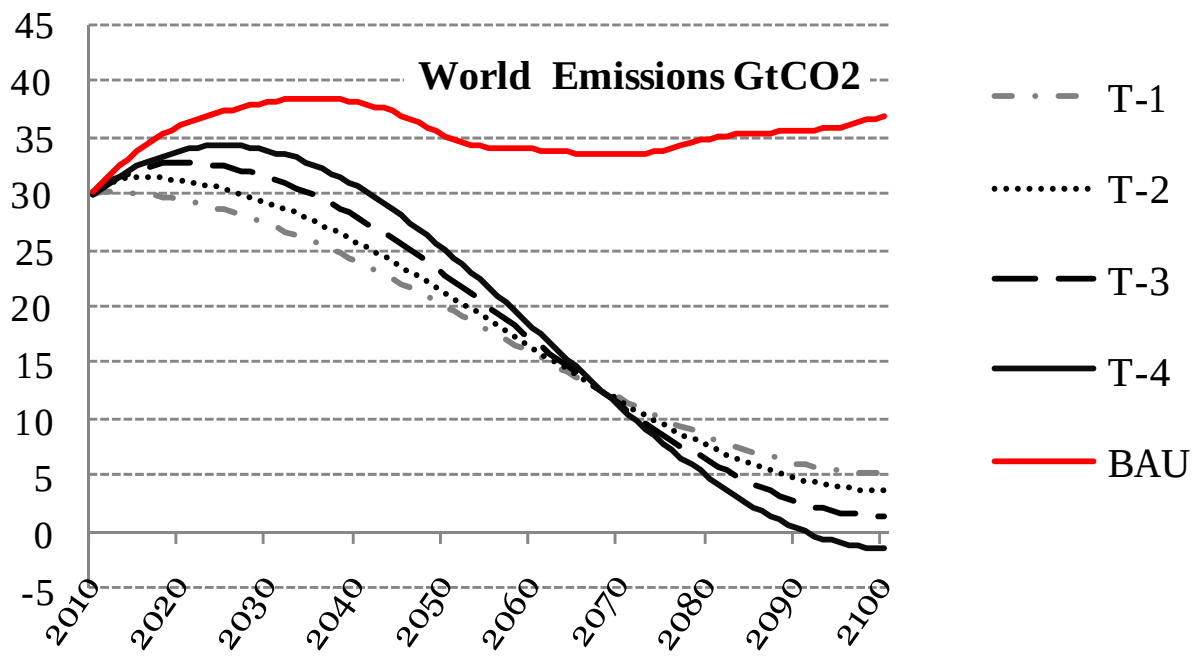
Global GDP variation between climate and reference scenarios



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

Global GDP variations between stabilization and reference scenarios