

Climate policies: what strategic space for oil producers?

Insights from the Imaclim-R model

**Henri Waisman, Jean-Charles Hourcade,
Olivier Sassi, Renaud Crassous, Céline Guivarch**

An attempt to delineate the terms of a pending question

- An historical linkage between climate policies (CP) and **energy security** in Oecd countries
- The **strategic response** of oil exporters to minimize « **adverse impacts** » of **CP** is still an underworked issue
- Game theoretic exercises provide very useful insights but hardly incorporate how:
 - in an ETC framework, oil producers can discourage oil importers from supporting « out of oil » policies
 - political parameters that could affect the strategic options of both agents
- Prior to analysing the 'game', necessity to better understand the **bounds and shape of the playing field**

Bounds and shape of the playing field

- **Three interaction levels**

- Within oil markets
- Between oil markets and energy markets
- Between energy markets and the overall GE effects

- **A non perfect expectation context**

- **Uncertainties** about the acceptability of a coordinated climate policies in Oecd?
 - willingness to pay of energy consumers
 - geopolitical parameters supporting such a political will
- **Uncertainties** in oil supply dynamics
 - Middle-East politics and Opec solidarity
 - Oil reserves

Opec's strategic space : 2 sets of determinants

- **Oecd + non Opec world behaviors between two extreme opposites**
 - Rhetorical CP in an ultimately Coal-To-Liquid (CTL) fueled economy
 - Constraints on nuclear energy
 - Biofuels development limited by land-use
 - No profitable alternative to liquid fuels in the transport sector in the next decade
 - Strong climate policies aiming at 450 ppm
 - « Carbon tax » increase in response to any cut in oil prices
 - High energy efficiency in end-use equipments
 - Deployment of low emission technologies & carbon sequestration
- **Technical parameters, between optimism and pessimism**
 - Frictions on the CTL
 - Frictions on oil production capacities

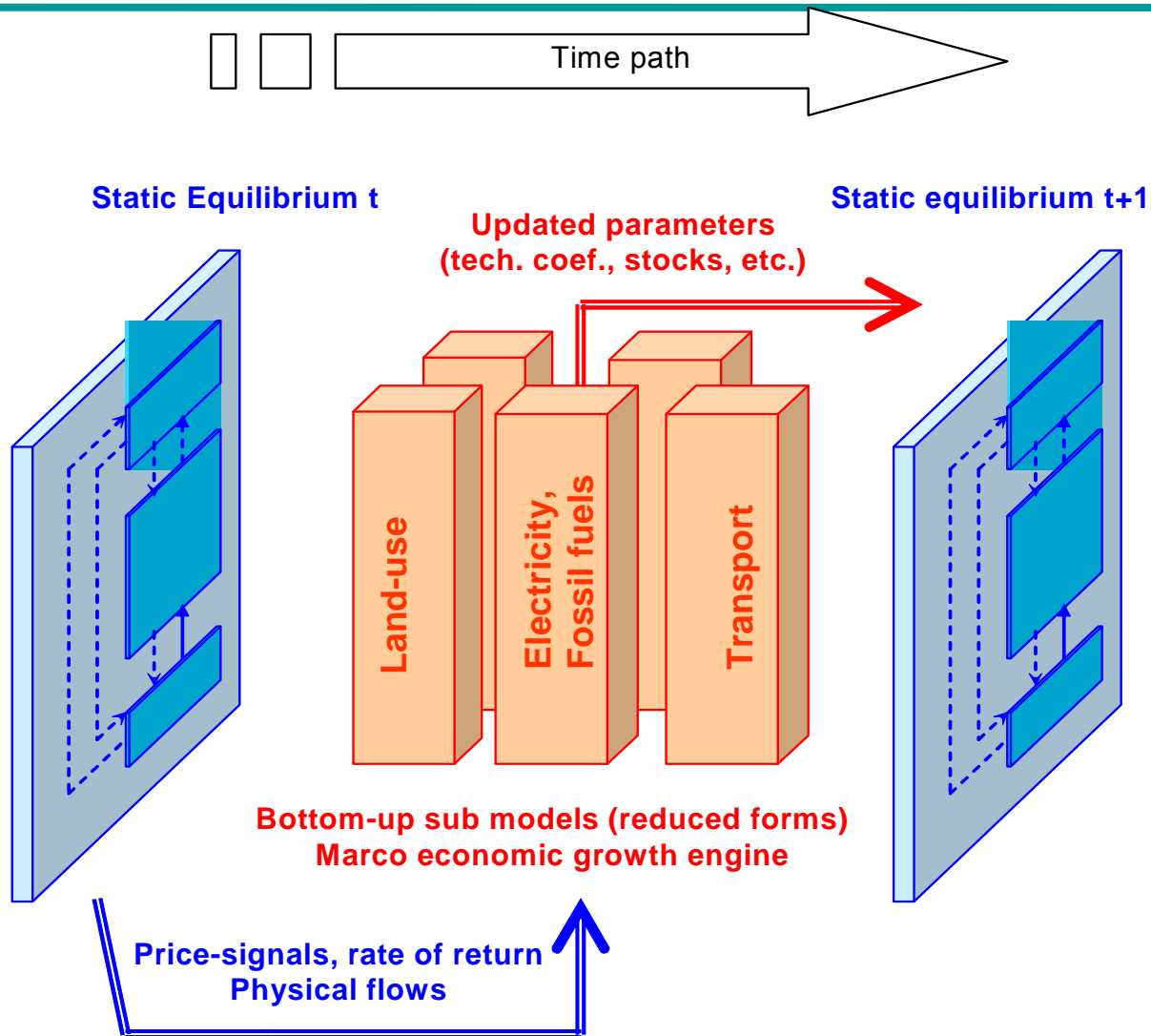
Opec's strategic space : the modelling challenge

- Capturing **intertwined interaction levels**
 - Within oil markets
 - Between oil markets and energy markets
 - Between energy markets and the overall GE effects
- With a specific attention to the **time profile of impacts** on :
 - Oil rents of Middle-East producers
 - GDP in Oecd oil-importing countries

The tool: the Imacsim-R model

- **A 12-region and 12-sector hybrid model**
 - 5 energy sectors (Mtoe/\$)
 - 3 transport sectors (pkm/\$)
 - 4 non-energy sectors (\$)
- **A recursive and modular architecture**
 - **Equilibrium of all flows** at each point of time under short-term constraints
 - Static consistency in quantities and values
 - **Moving constraints** informed by explicit dynamic relationships
 - Non perfect anticipations
 - Dynamic consistency of investments/ technologies / infrastructure
- Those interactions capture both **short-term disequilibria** and **long-term growth** dynamics

A recursive and modular architecture



Modelling oil supply

- **Explicit description of oil reserves**

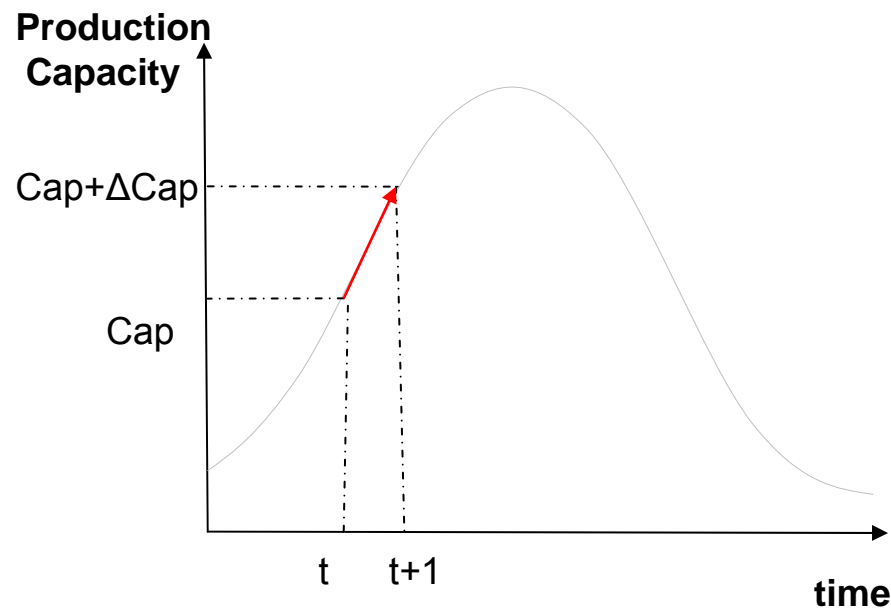
- Physical quantities (MBarrel)
- Distribution by region
- Differentiation between conventional and non-conventional resources
- Categories distinguished by the cost of exploration and exploitation

- **2 categories of oil producers**

- Non Middle East countries = « fatal producers »
 - return on investments
- Middle East countries = « swing producers »
 - strategic behavior

Modelling oil supply for « fatal producers »

- **Geological constraints on exploration and exploitation**
 - Information effect
 - Depletion effect
- **Inertia** in the deployment of production capacities
- **Hubbert curves** for each category of oil



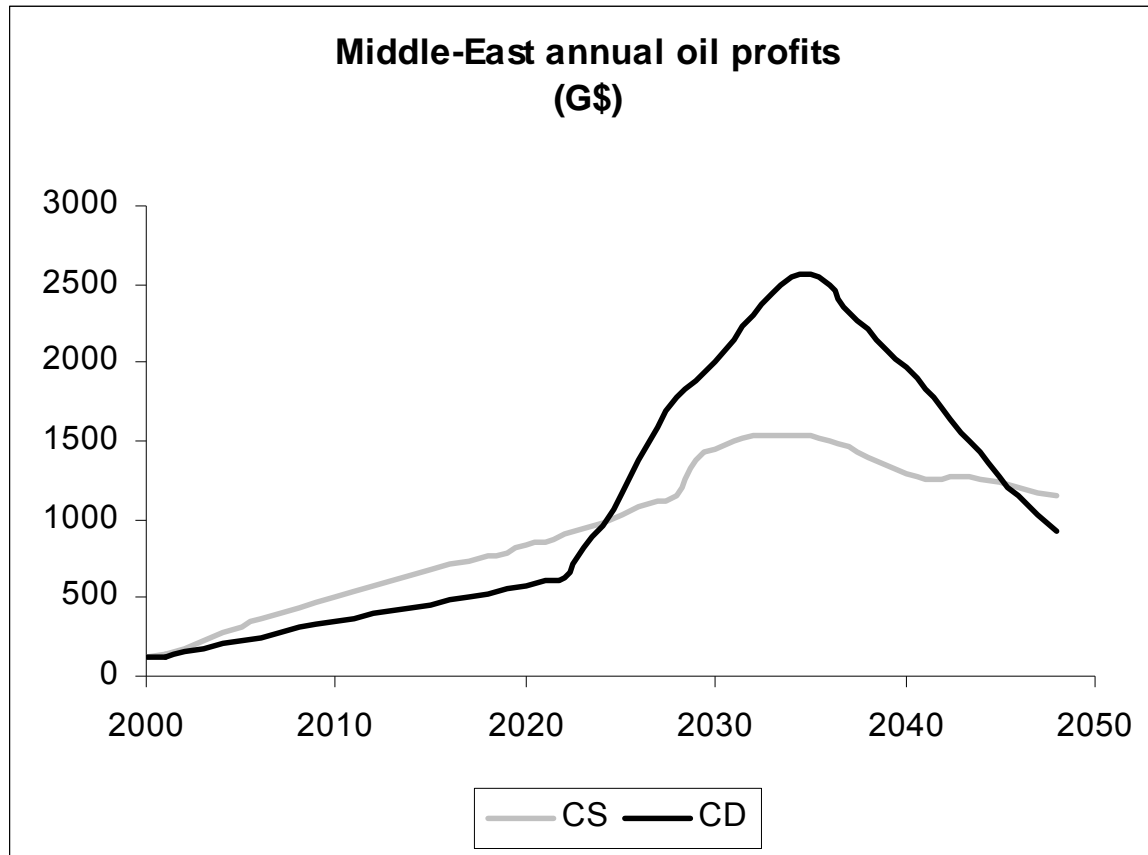
Modelling oil supply in Middle-East countries

- **Middle-East countries, a « swing producer »**
 - Cartel's objective : price or market share target
 - Anticipation of other agents' decisions
 - Perfect knowledge of ultimate resources
- **Middle East countries can influence on :**
 - The evolution of the energy system
 - Oil demand and supply
 - Oil substitute
 - The level of oil-dependency in energy-importing countries

Strategic behaviors with 2 extreme bounds

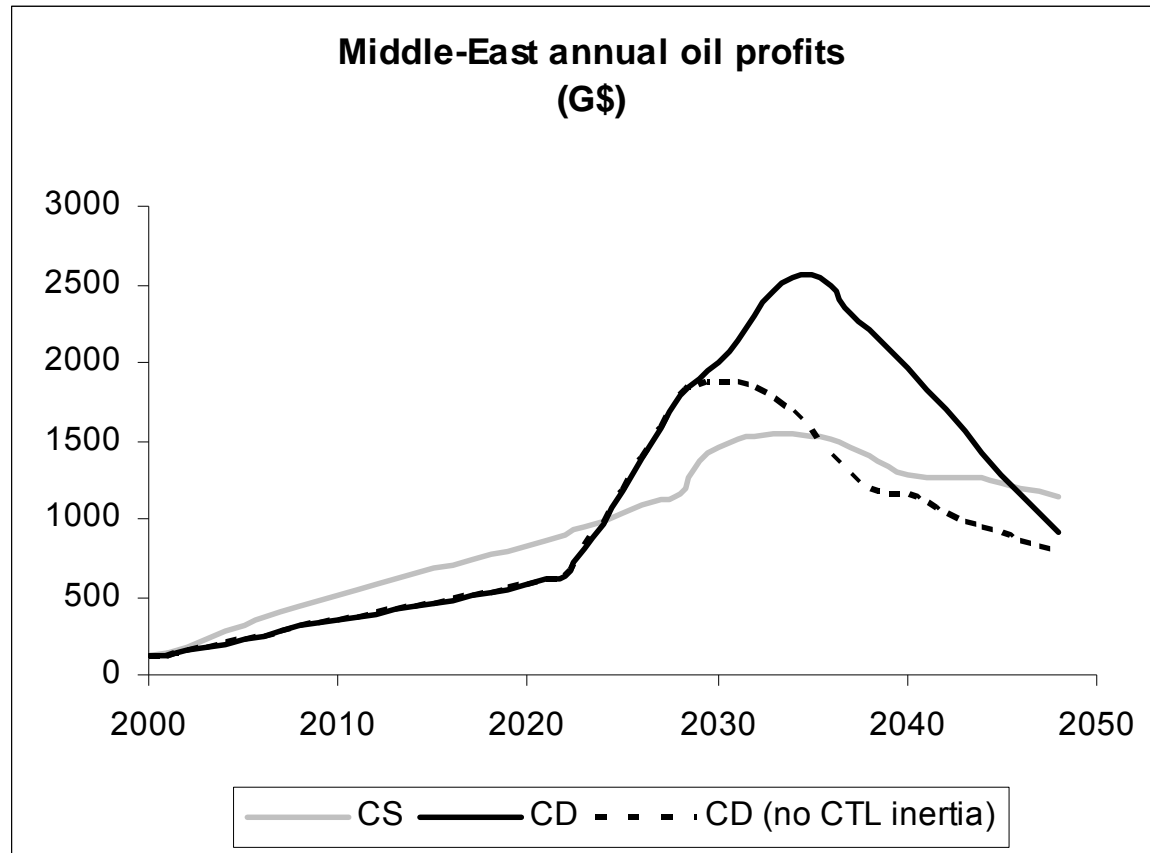
- **Trade-off between 2 time profiles of oil revenues**
 - Discouraging adaptation of the energy system to future oil scarcity
 - Taking advantage of the short-term rents
- **Decision variable**
 - Amount of **investment** in oil capacities
- **Two extreme strategies**
 - **The « Capacity Shortage» strategy (CS)**
 - Very low investment in Middle-East oil producing capacities
 - **The « Capacity Development» strategy (CD)**
 - Very high investment in Middle-East oil producing capacities

The trade-off in a no climate policy world



The trade-off in no climate policy world

Sensibility to the inertia assumption on CTL



A trade-off conditioned by discounting

| Middle-East oil discounted profit (* 1000 G\$) | | | |
|--|-------------|-------------|----------------------------------|
| Discount rate | CS strategy | CD strategy | CD strategy No inertia on CTL |
| 0% | 45.65 | 54.06 | |
| 1% | 34.14 | 39.53 | |
| 6% | 10.26 | 10.28 | |
| 7% | 8.47 | 8.22 | |
| 10% | 5.16 | 4.60 | |

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| ... | ... | ... | |

CD

CS

Both extreme behaviors have a broad « validity space »

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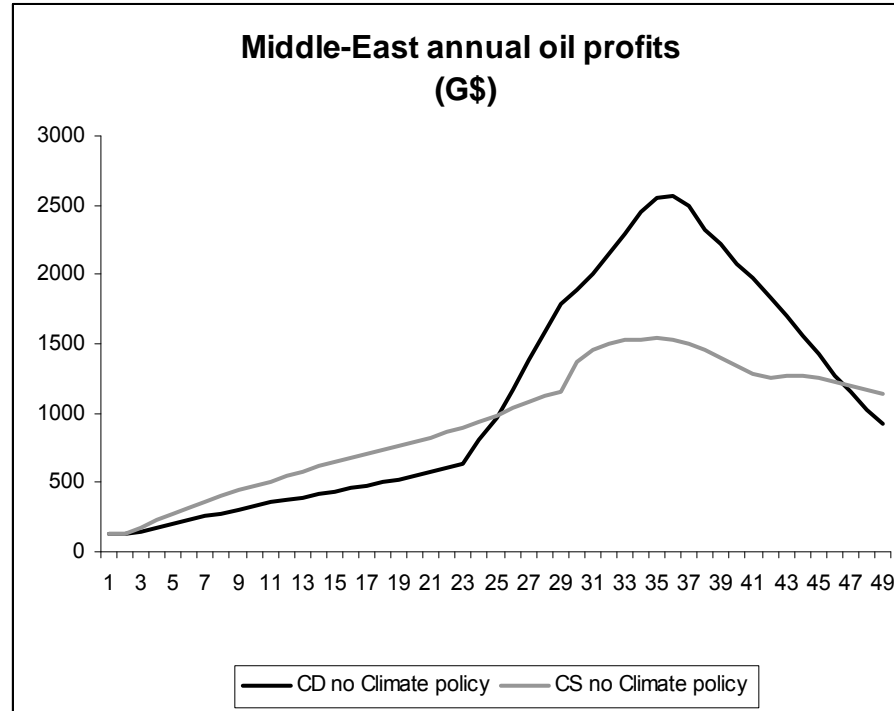
CD

CS

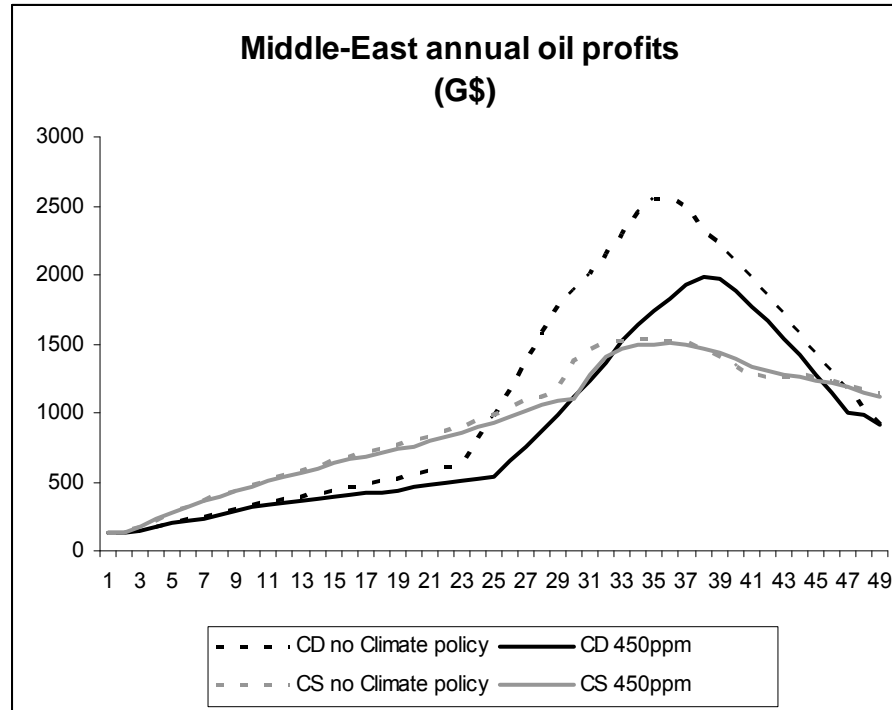
Both extreme behaviors have a broad « validity space »

The strategic space of Middle-East producers is wide

The trade-off in a strong climate policy context



The trade-off in a strong climate policy context



How do Climate Policies change the trade-off ?

| Middle-East oil discounted profit (* 1000 G\$) | | | | |
|--|-------------------|--|-------------------|--|
| Discount rate | CS scenario | | CD scenario | |
| | No Climate Policy | | No Climate Policy | |
| 0% | 45.65 | | 54.06 | |
| 1% | 34.14 | | 39.53 | |
| 6% | 10.26 | | 10.28 | |
| 7% | 8.47 | | 8.22 | |
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| ... | ... | | ... | |

CD

CS

How do Climate Policies change the trade-off ?

| Middle-East oil discounted profit (* 1000 G\$) | | | | |
|--|-------------------|----------------|-------------------|----------------|
| Discount rate | CS scenario | | CD scenario | |
| | No Climate Policy | Climate Policy | No Climate Policy | Climate Policy |
| 0% | 45.65 | 44.31 | 54.06 | 41.76 |
| 1% | 34.14 | 33.09 | 39.53 | 30.46 |
| 6% | 10.26 | 9.94 | 10.28 | 8.06 |
| 7% | 8.47 | 8.20 | 8.22 | 6.51 |
| 10% | 5.16 | 5.01 | 4.60 | 3.78 |
| ... | ... | | ... | |

The strategic space of Middle-East producers is strongly narrowed

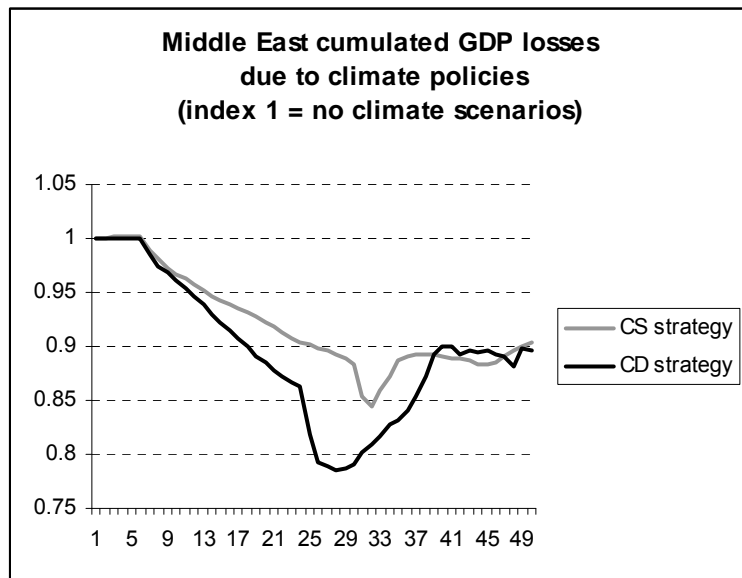
➤ Reduced to CS-like strategies

Can Opec discourage a climate coalition?

- Negative impact of climate policies on Middle-East GDP for both strategies

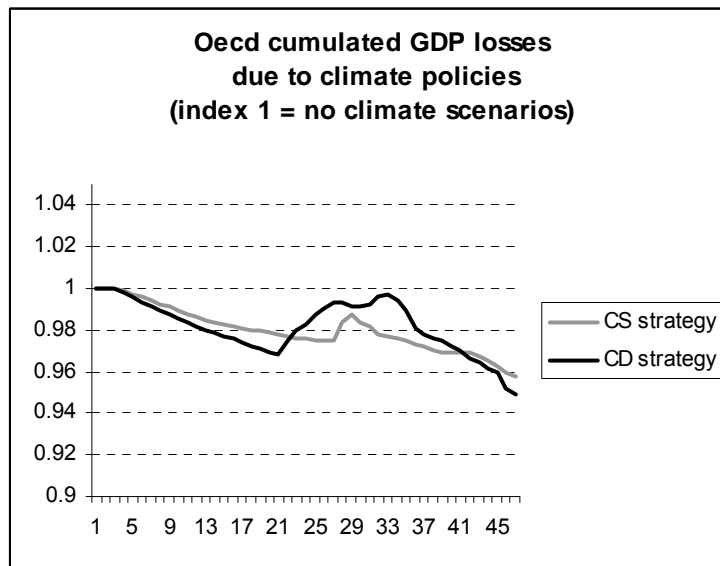
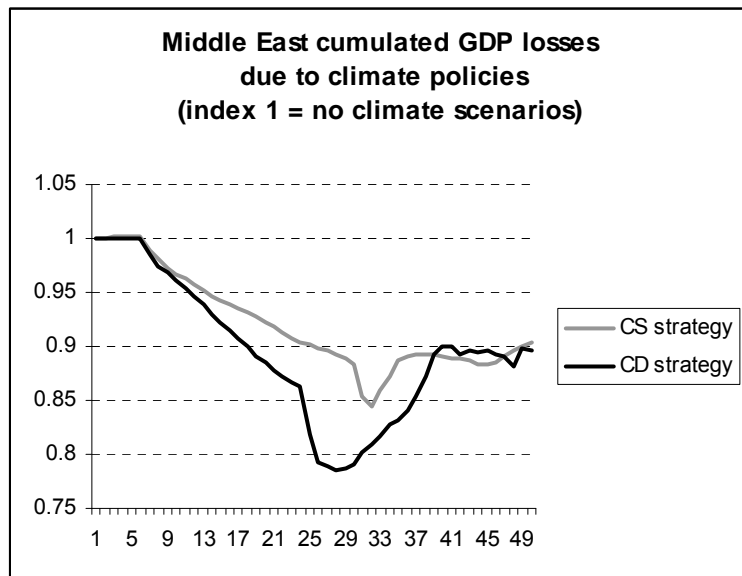
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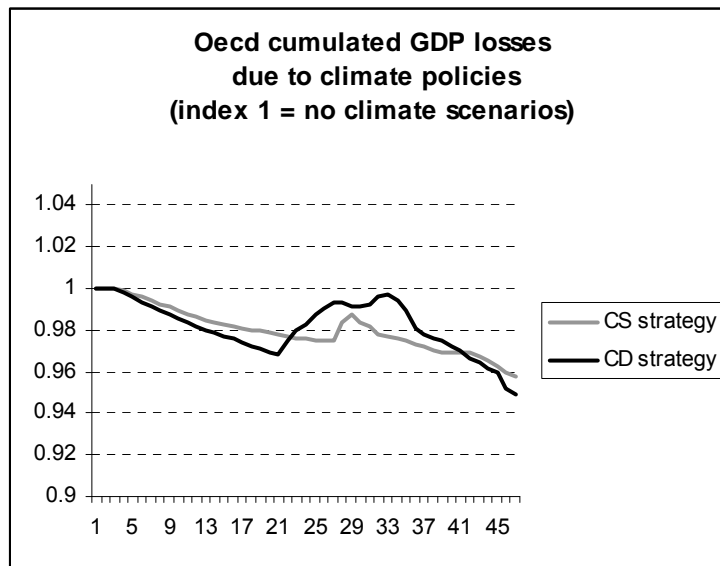
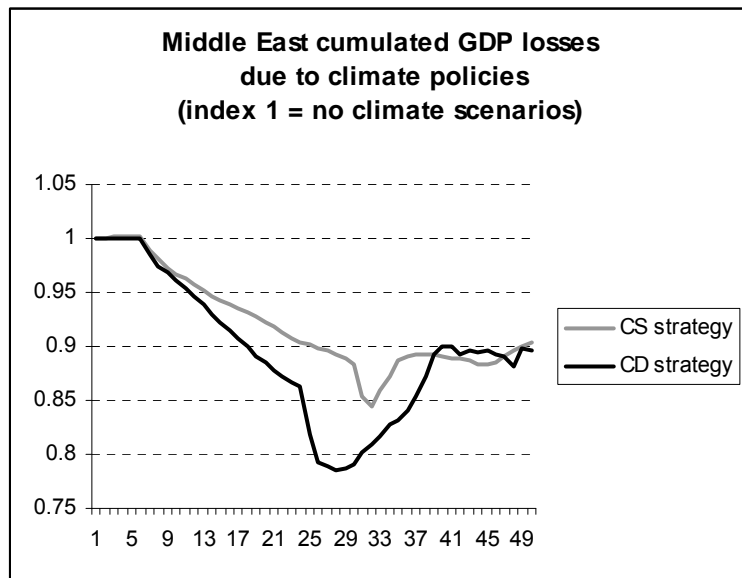
Can Opec discourage a climate coalition?

- Negative impact of climate policies on Middle-East GDP for both strategies
- Oecd's willingness to pay for climate may be bounded by « some costs»

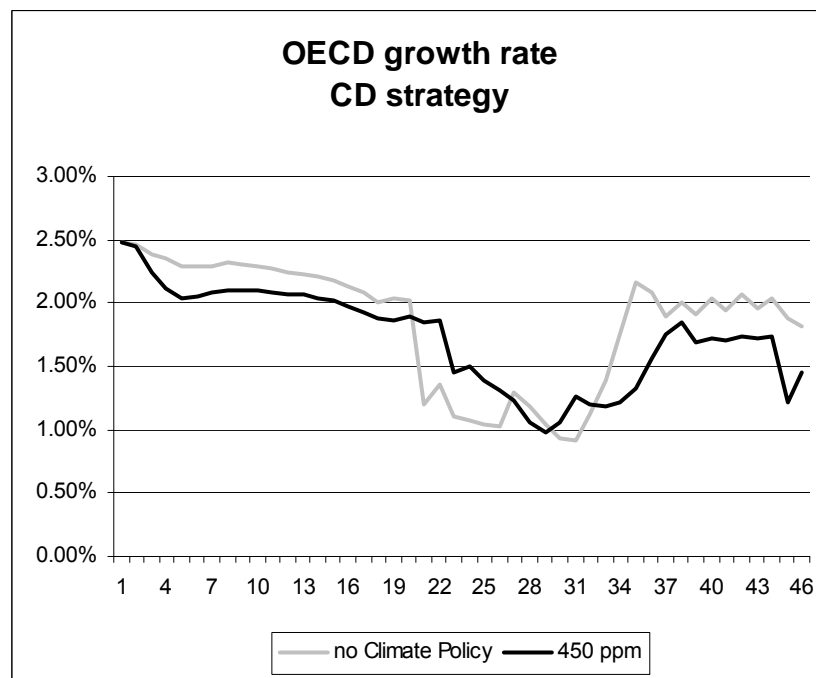
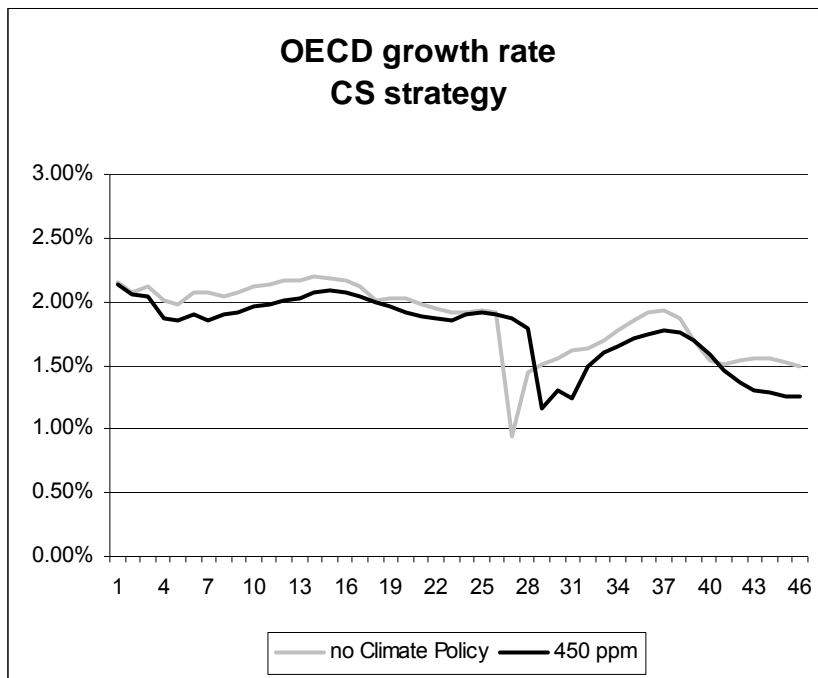


Can Opec discourage a climate coalition?

- Negative impact of climate policies on Middle-East GDP for both strategies
- Oecd's willingness to pay for climate may be bounded by « some costs»
 - The costs depend on the Middle-East strategy
 - Understand Oecd's perception of the climate policy's effects



Climate policies, Opec's strategy and Oecd's growth (1/3)



2 dimensions of the climate policy's impact on Oecd growth:

- Aggregated GDP losses
- Smoothing of the oil crisis' effects

Climate policies, Opec's strategy and Oecd's growth (2/3)

- Aggregated GDP losses
- Indicator : discounted GDP

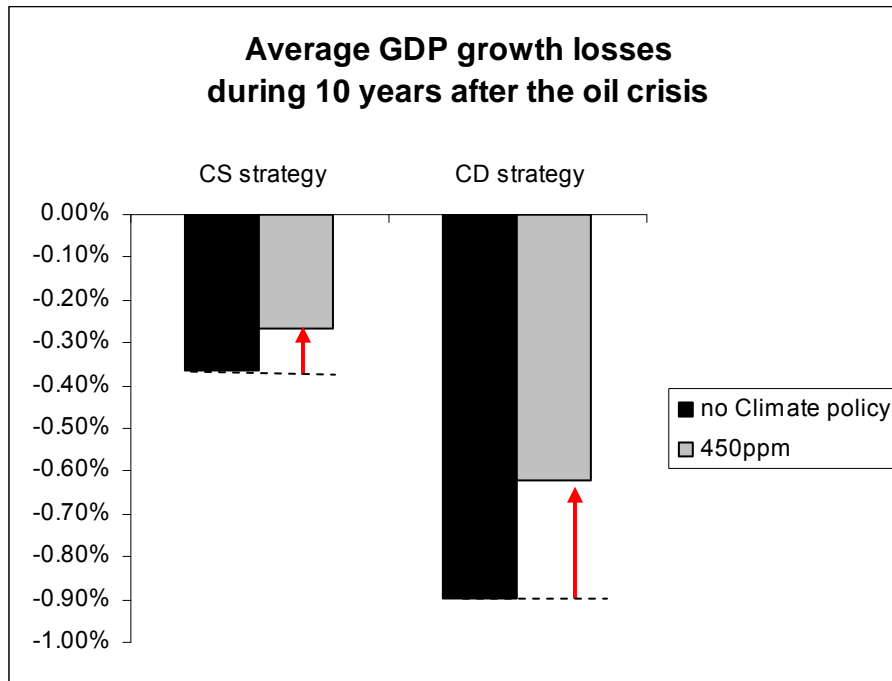
| Oecd discounted GDP losses due to climate policy | | |
|---|-------------|-------------|
| discount rate | CS strategy | CD strategy |
| 1% | -2.11% | -1.93% |
| 6% | -1.49% | -1.48% |
| 7% | -1.38% | -1.40% |
| 10% | -1.09% | -1.20% |

- Opec's strategy inducing the biggest losses can change with the discount rate
- Discounted losses due to climate policies are close in the two Opec strategies

➤ The two Opec strategies are unlikely to induce different climate responses on the basis of this only criterion.

Climate policies, Opec's strategy and Oecd's growth (3/3)

- Sensibility to oil shock
- Indicator : GDP losses during 10 years after the oil crisis



- The worst crisis always occurs with the CD strategy
- The smoothing effect of climate policies is particularly important in the CD strategy

➤ Opec's CD strategy strongly encourages the climate policy for growth smooting purpose

Summary of the results

- Without climate policy, a wide range of strategies are profitable for the Opec
 - Uncertainty for oil-consumer countries
 - Great probability of facing a CD-like strategy
 - Climate policies reduce the range of Opec's strategic behaviors
 - CS-like strategy more profitable
 - Use of the market power to discourage the climate coalition
 - In a CD-like strategy a climate policy is very likely
 - CS-like strategy could be effective to avoid the climate policy
- Credibility of climate policy induces Opec's adoption of CS-like strategies
- Early tensions on oil market
 - Smoothing of the oil crisis' impact on Oecd



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