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Should we ban unconventional oil extraction to reduce global warming?

Samuel Carrara[1] and Emanuele Massetti[2]

[1] Fondazione Eni Enrico Mattei (FEEM) and Centro Euro-Mediterraneo sui Cambiamenti Climatici (CMCC), Milan, Italy
[2] Georgia Institute of Technology, Atlanta, GA, USA

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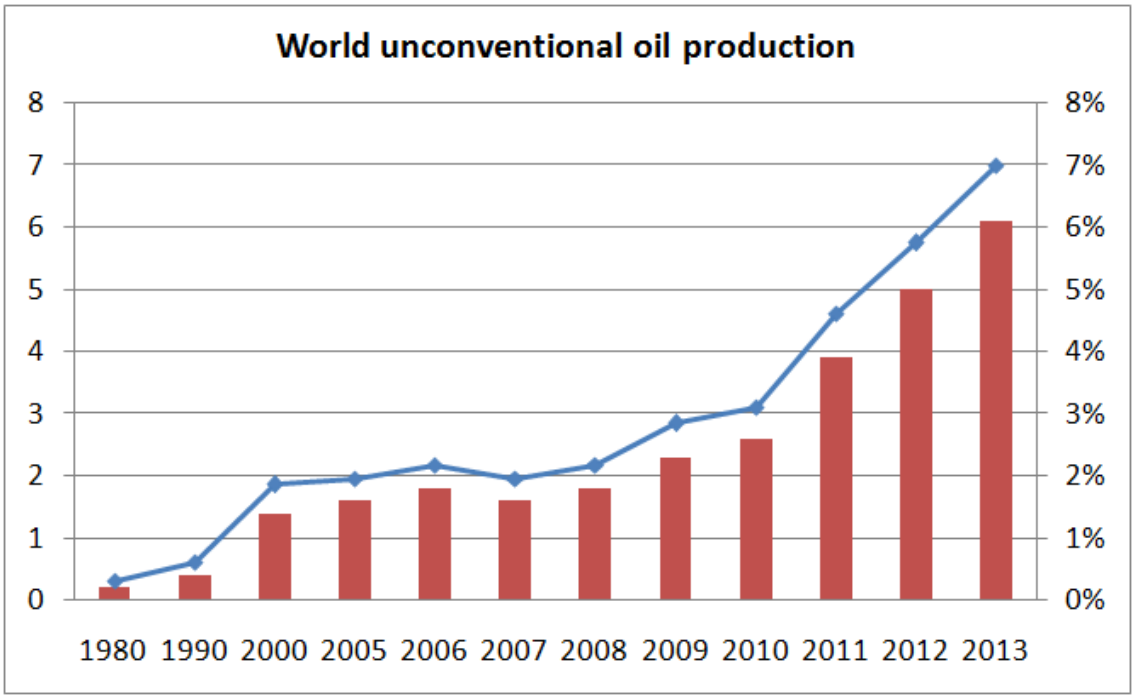
Introduction – Definitions

- According to the International Energy Agency (IEA), “conventional oil is a category of oil that includes crude oil and natural gas liquids and condensate liquids, which are extracted from natural gas production. Unconventional oil consists of a wider variety of liquid sources including oil sands, extra heavy oil, gas to liquids and other liquids” (IEA, 2014).
- “The categories conventional and unconventional do not remain fixed, and over time, as economic and technological conditions evolve, resources hitherto considered unconventional can migrate into the conventional category”.
- According to the US Department of Energy (DOE), “unconventional oils have yet to be strictly defined” (Gordon, 2012).

Introduction – Scenario (I)

- In 2013, unconventional oil production was equal to 6.1 mb/d, about 7% of the total (89.4 mb/d) and mostly related to oil sands in Canada and light tight oil in the United States (about 2-2.5 mb/d each) (IEA, World Energy Outlook, 2014).
- Abstracting from short-term fluctuations of oil price, considerable expansion is forecast for the next years: 10-11 mb/d in 2020, more than 11% of the total (91-95 mb/d, depending on scenarios) (IEA, World Energy Outlook, 2014).



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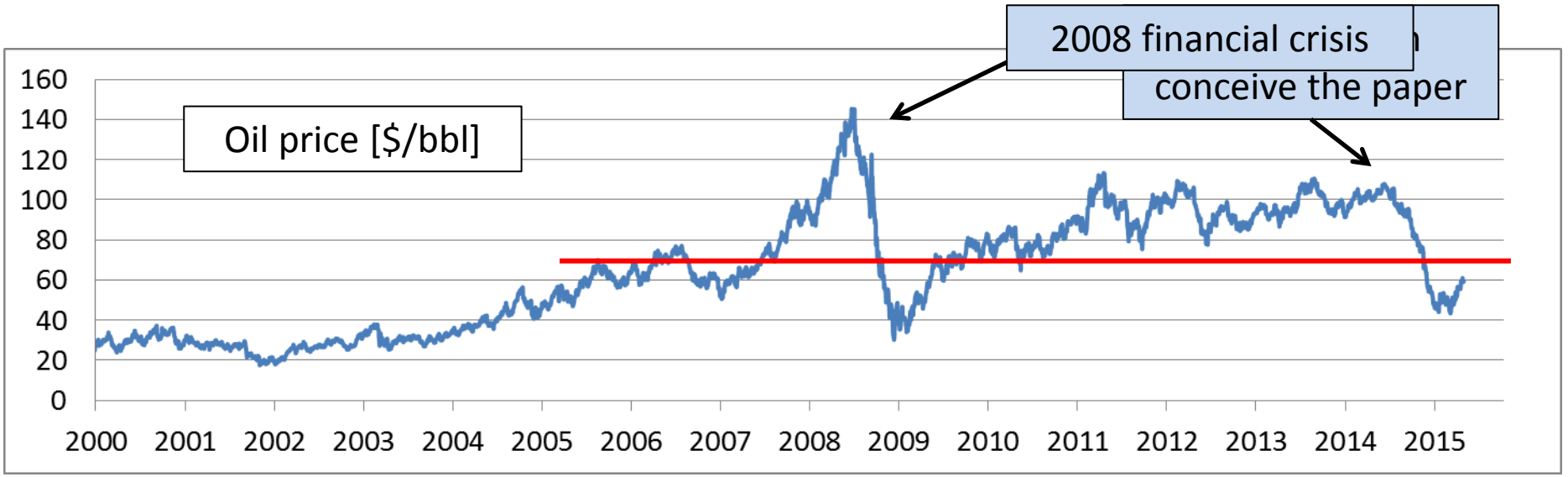
Introduction – Scenario (II)

- The profitability of unconventional oil production is normally guaranteed with oil price above 60-70 $/bbl.
- The recent expansion of unconventional oil production has been boosted by a decade with high oil prices.
- Symmetrically, the fall which took place in the second half of 2014 is likely to have impacts on production and on future development programs.



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Introduction – Scenario (III)

- Huge investments in infrastructure to connect North American sites to the global markets are ongoing, planned or proposed.

Enbridge Northern Gateway Pipeline

Introduction – Environmental and climate concerns (I)

- The extraction of unconventional fossil fuels causes larger environmental damages than the extraction of conventional fossil fuels:

  - large volumes of water are needed

  - heavy chemicals are added to water and pollute the subsoil

  - more disruptive extraction processes are required (fracking, etc.)

- Emissions from the final use of oil products (e.g. gasoline) from unconventional oil is the same as conventional oil, but the extraction and processing phases of unconventional oil are more energy intensive, thus resulting in higher emissions. The European Union (EU) estimates that oil sands lead to 22% more emissions than conventional oil (Brandt, 2011).

Introduction – Environmental and climate concerns (II)

- The exploitation of unconventional oil resources thus causes growing tensions:

  - in **local** terms, due to the higher direct **environmental** impacts

  - in **global** terms, due to the higher **climate** impacts

- With no domestic production of unconventional oil, local environmental damages are not a primary concern in the European Union. However, the EU is very concerned by the impact of the additional carbon emissions from unconventional oil extraction on global warming.

Introduction – The EU proposal

- EU regulators have considered to stigmatize tar sands oil production in Canada in the context of the Fuel Quality Directive (FQD) by labeling it as a dirty fuel and imposing a tariff that reflects the social cost of the additional carbon dioxide emissions in the extraction phase.
- Eventually (6th October 2014), the directive proposal of the EU Commission was much milder than initially expected ("The proposed methodology requires suppliers to report a (European) Union average greenhouse gas emission intensity per fuel with an option to report supplier specific values").

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EU fuel directive demonizes oil sands

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EU proposal scraps mandatory 'dirty' label for tar sands

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Policy questions

Relevant policy questions are:

- How large is the effect of increased use of unconventional fossil resources on global warming?
- What would the expected climate benefit and the cost of achieving this benefit be if the use of unconventional fossil resources were banned?
- Would it be possible to obtain the same climate benefits using different policy tools?

Exercise framework

Two policy scenarios have been considered (in addition to the reference baseline):

- Global ban of unconventional oil extraction
- Unilateral European ban of unconventional oil, i.e.:

    1) no domestic extraction

    2) no imports from abroad

The WITCH model – Introduction

WITCH – World Induced Technical Change Hybrid

- Climate-energy-economic IAM (Integrated Assessment Model) → Socio-economic impacts of climate change
- Hybrid: aggregated, top-down, inter-temporal optimal-growth model + disaggregated description of the energy sector

CAJAZ
(Canada, Japan, New Zealand)

KOSAU
(R. of Korea, South Africa, Australia)

WITCH – Oil extraction and trade (I)

- Total oil demand is given by:

$$OIL(t,n) = \sum_{oilg} OIL_{prod}(t,n,oilg) \pm OIL_{imp/exp}(t,n)$$

where the symbol *oilg* indicates the different oil categories modeled in WITCH, grouped in the conventional and unconventional families.

- WITCH does not model bilateral oil trade: the equilibrium in the international market is found globally, and in particular it requires that the sum of the net import/export in the different regions be equal to zero:

$$\sum_{n} OIL_{imp/exp}(t,n) = 0$$

WITCH – Oil extraction and trade (II)

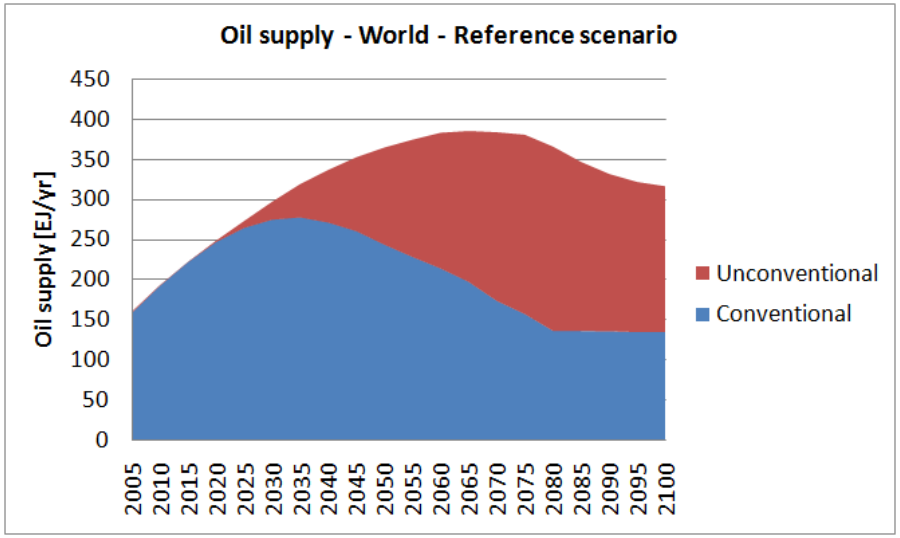
- The international price of oil is thus endogenous and it emerges as the outcome of a non-cooperative Nash game among the thirteen world regions. A region-specific cost mark-up (positive or negative) is then added to it in order to take into account local factors which determine the final cost for local consumers.
- Oil production cannot exceed the amount of oil capacity achieved in each region, which can vary over time via capital depreciation (-) or dedicated investments (+).

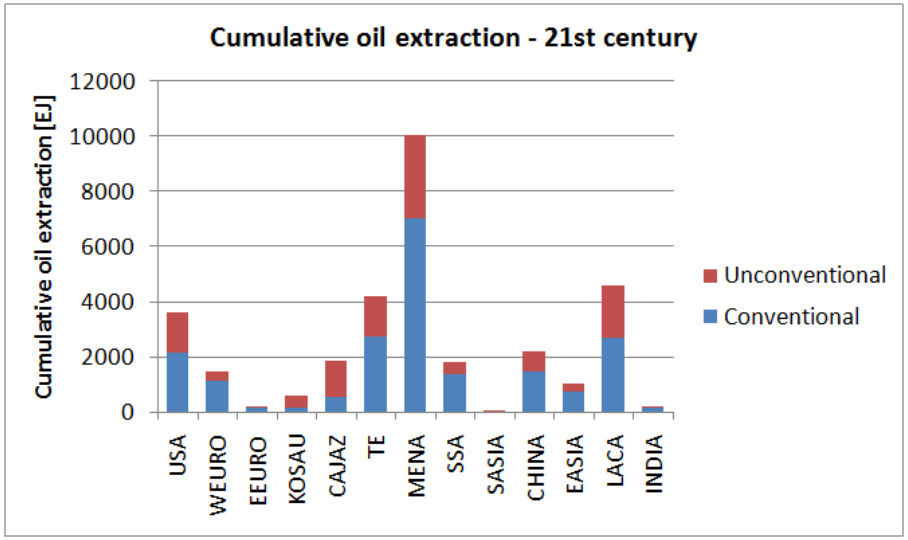
$$OIL_{cap}(t+1,n,oilg) = OIL_{cap}(t,n,oilg) \cdot (1-\delta) + \Delta OIL_{cap}(t,n,oilg)$$

$$I\_OIL_{cap}(t,n,oilg) = COST\_OIL_{cap}(t,n,oilg) \cdot \Delta OIL_{cap}(t,n,oilg)$$

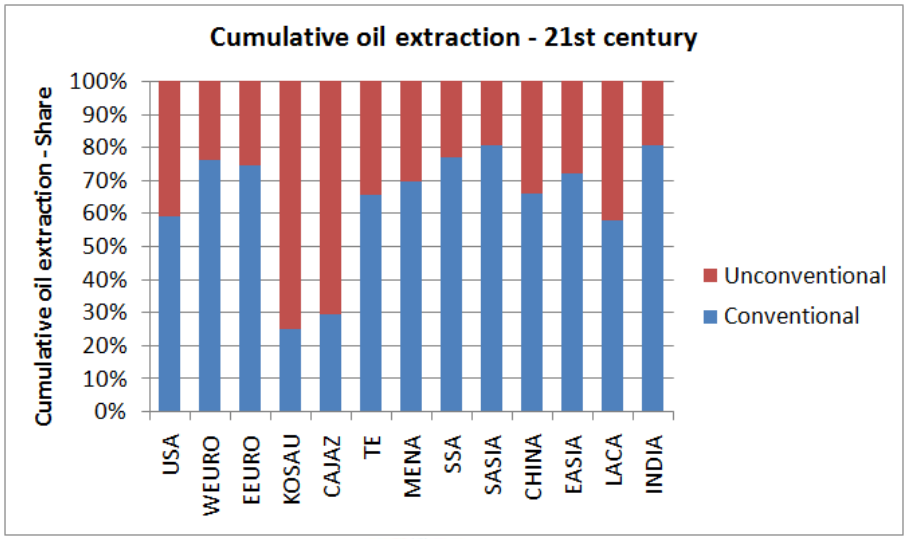
- The cumulative extraction cannot exceed the overall resource potential.
- Oil production, consumption and trade eventually contribute to the definition of GDP, aggregate consumption, and welfare.

Reference scenario





- Calibration year: 2005.
- Unconventional oil production overcomes the conventional one in the second part of the century.
- KOSAU and, above all, CAJAZ are the regions whose oil production is mostly unconventional.



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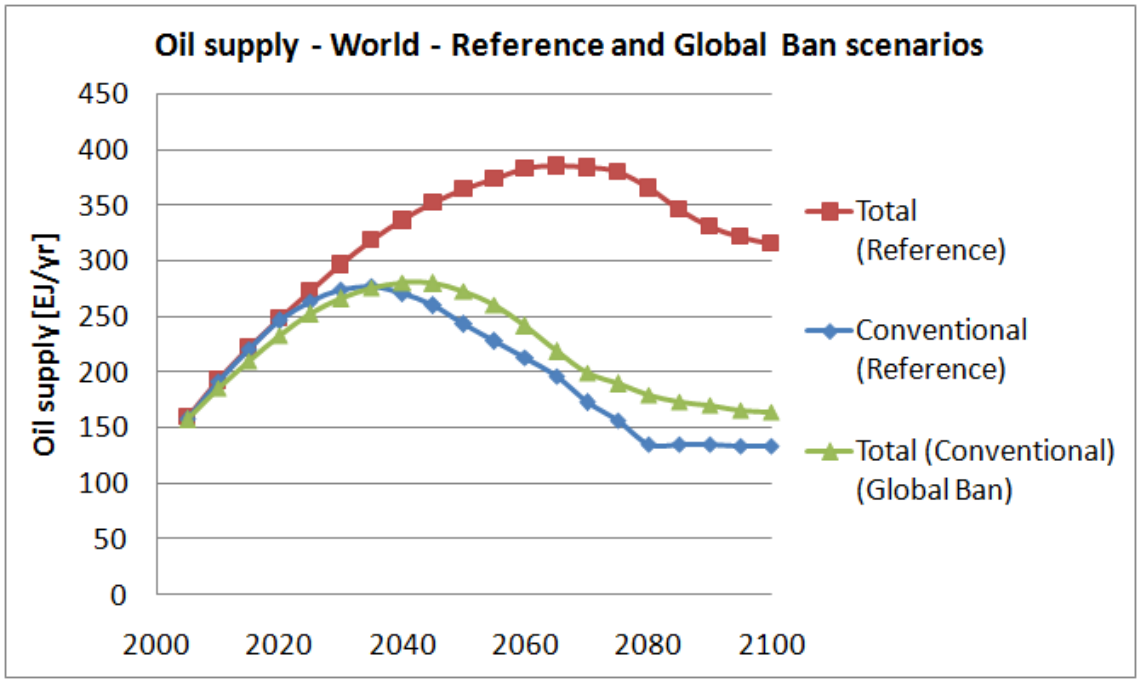
Global Ban scenario – Oil supply



- The increase in conventional oil production (+12% in 2050, +23% in 2100) does not compensate the absence of the unconventional contribution, therefore global oil supply decreases (-25% in 2050, -48% in 2100).
- The contraction of oil consumption is almost fully reflected in a reduction of total primary energy use.

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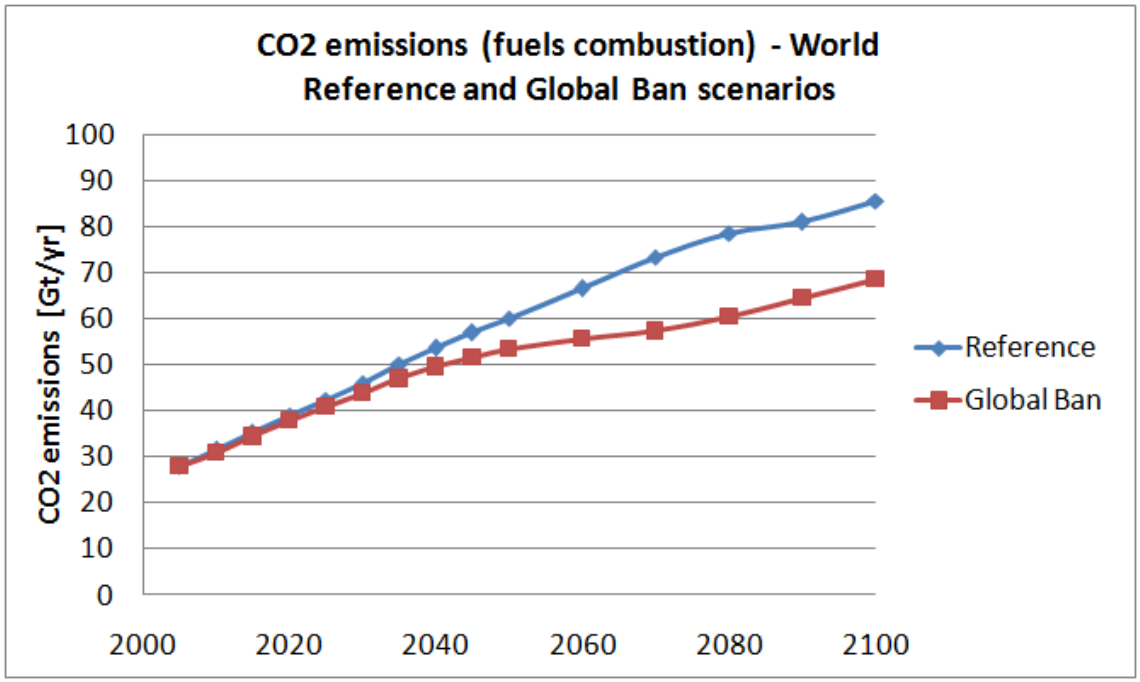
Global Ban scenario – Climate impacts (I)



Global carbon dioxide emissions from fuels combustion decrease by 5% in 2030, by 11% in 2050 and by 20% in 2100. The cumulative reduction of emissions is equal to 122 $GtCO_2$ from 2010 to 2050 and to 906 $GtCO_2$ from 2010 to 2100, which represents 6% and 16% of the cumulative emission amount in the Reference case, respectively.

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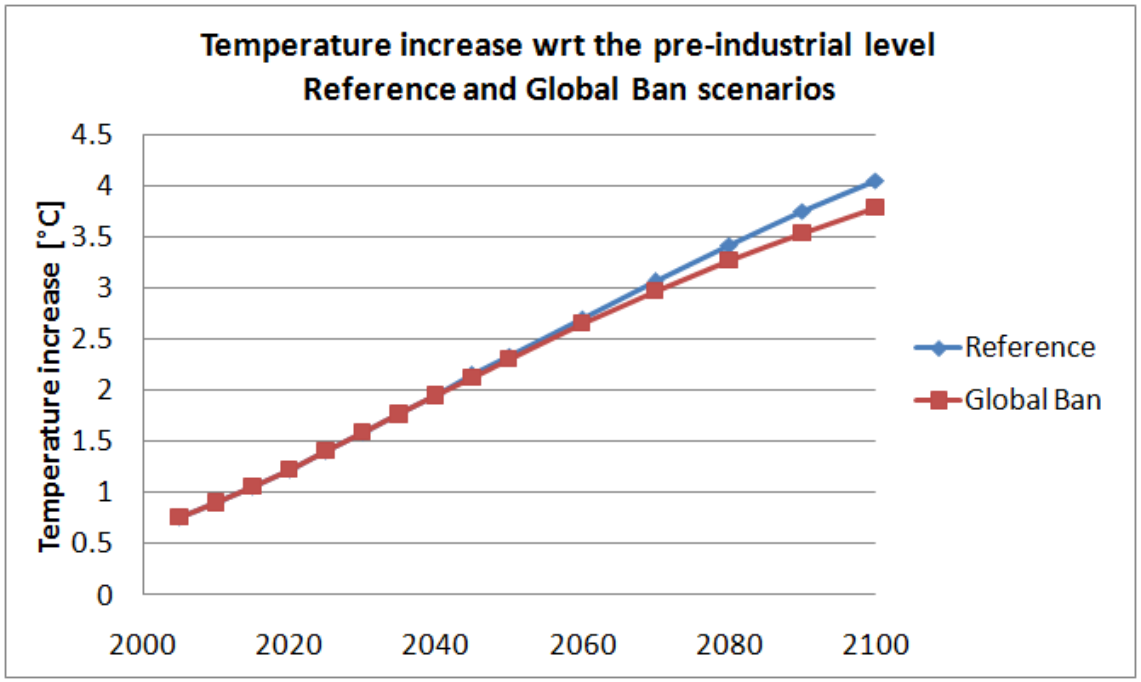
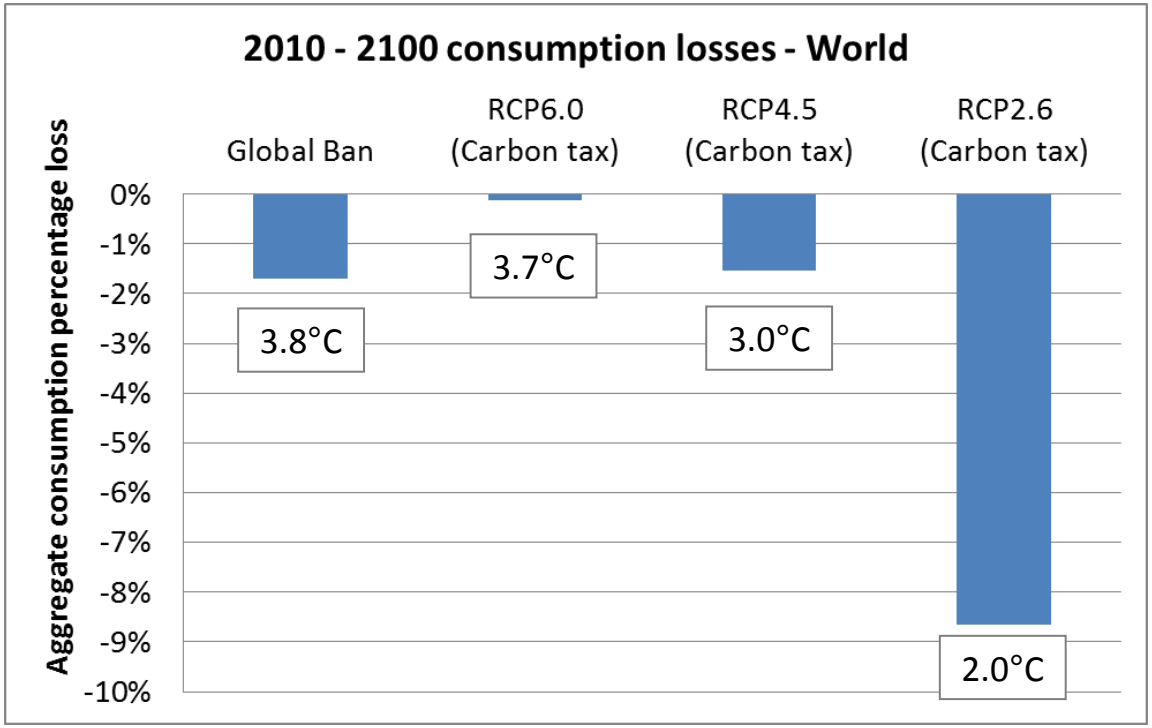
Global Ban scenario – Climate impacts (II)



The increase of mean global temperature is unchanged by the policy in 2050 because the climate system is characterized by a strong inertia and unconventional oil would be mostly adopted in the second part of the century. In 2100 the ban of unconventional oil reduces the temperature increase by 0.3°C, from +4.1°C to +3.8°C.

Global Ban scenario – Economic performance (I)



Due to the lower oil demand, global consumption declines: from 2010 to 2100 the undiscounted loss is 1.7% of the reference aggregate consumption. However a more flexible policy approach based on a carbon tax achieving the same climate results would cost about fifteen times less; symmetrically, a much better climate target would be achievable at the same cost.

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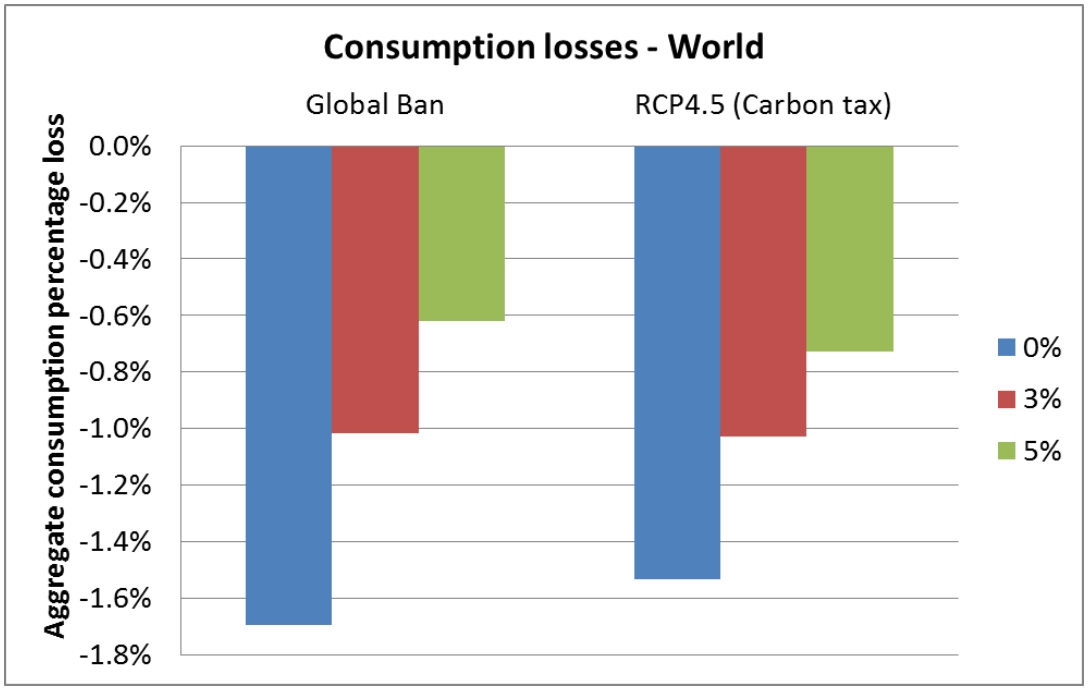
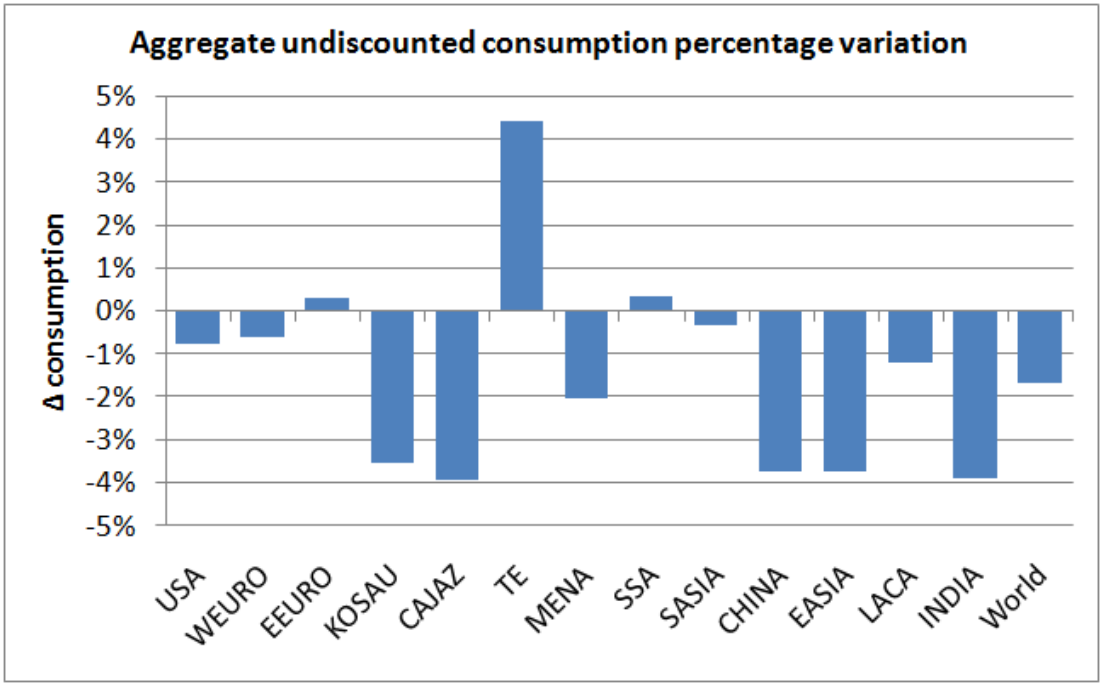
Global Ban scenario – Economic performance (II)

- The cost difference is the result of concentrating all emission reduction efforts on one single sector rather than distributing it across many sectors, letting the model find the optimal abatement allocation.
- Policy costs in the Global Ban case are more sensitive to the discount rate.



Global Ban scenario – Economic performance (III)



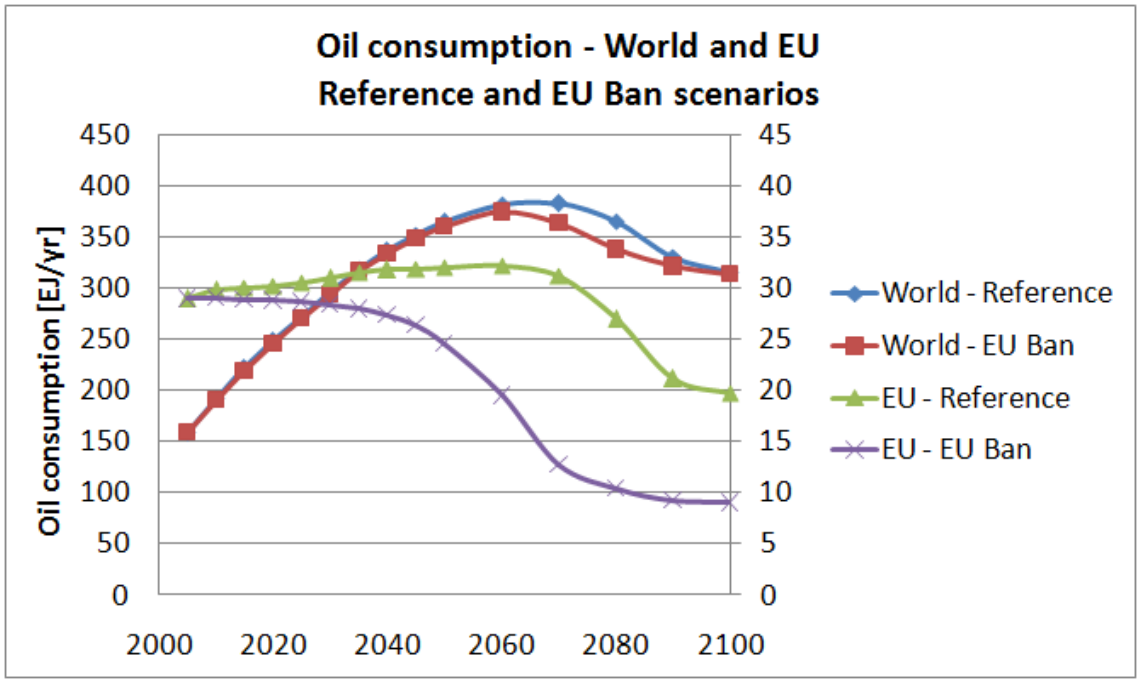
- Stronger economic impacts in:

  1) largest producing regions (especially CAJAZ and KOSAU, then MENA and LACA)

  2) the main oil importers (CHINA, EASIA, INDIA)

- The peculiar behavior of Transition Economies

EU Ban scenario – Oil demand



In 2050 Europe reduces its oil demand by 23% and global demand only decreases by 1%. In 2100 Europe cuts oil consumption by half but at global level demand is less than 1% lower → The European demand reduction is almost completely compensated by the rest of the world due to the lower prices.

EU Ban scenario – Climate impacts and economic performance

- In Europe carbon dioxide emissions decline by 12% in 2050 and 20% in 2100, but the reduction in global terms is negligible (less than 1% both in 2050 and 2100). Accordingly, the temperature increase with respect to the pre-industrial levels exhibits a very limited reduction (-0.03°C in 2100).
- The cost of limiting unconventional oil use falls on Europe while the benefit is shared among all other regions because they face less competition in the global oil market (the global price of oil declines, up to 5% at the end of the century).
- The consumption loss in Europe from 2010 to 2100 is equal to 0.4% of the reference aggregate undiscounted consumption.

Conclusions

- A global ban on the use of unconventional oil has important climate benefits but it is a very inefficient policy.
- A more efficient policy would tax GHG emissions independently from their source, sector and location. If we abstract from other environmental externalities (which are not the object of this work), the extraction of oil sands is not different from any other consumption or production activity that generates GHG emissions.
- A unilateral ban of the European Union on unconventional oil has no climate benefits and it is expensive for the region.

Policy messages

- If the main goal is carbon mitigation, the EU should avoid unilateral aggressive policies against unconventional oil, but should rather invest political capital to promote the implementation of economy-wide policies to penalize GHG emissions.
- Local negative environmental externalities from unconventional oil extraction are large and may justify a more conservative approach. However, local externalities require local policies. If policy makers are concerned by other externalities of unconventional oil extraction, they should apply specific policy tools that address those externalities and not an implicit carbon tax.

Thank you!

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