



CENTRE
INTERNATIONAL
DE RECHERCHE
SUR L'ENVIRONNEMENT
ET LE DÉVELOPPEMENT



Chaire Modélisation prospective
au service du développement durable

Economic Globalization, Global energy issues and Climate Change

China in global perspective

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6th Atlantic Workshop on Energy and Environmental Economics

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Motivation

- Rio+20 conference → Difficulty to lay out a coherent roadmap for addressing global challenges in the framework of sustainable development

Necessity to explore more in depth the link between sustainability and globalization processes

- **Energy** is a nodal point of the relations between **sustainability** and **globalization**.
- Focus on **China** → An economy that concentrates a combination of challenges related to this interplay
 - A major importer of exhaustible energy resources
 - The major carbon emitter : a crucial role in the international climate governance

Motivation

We investigate the twofold sustainability challenge posed to China by:

- Energy security
- The transition to a low-carbon economy

→ Under alternative visions of globalization processes

{ Goods
{ Capital flows

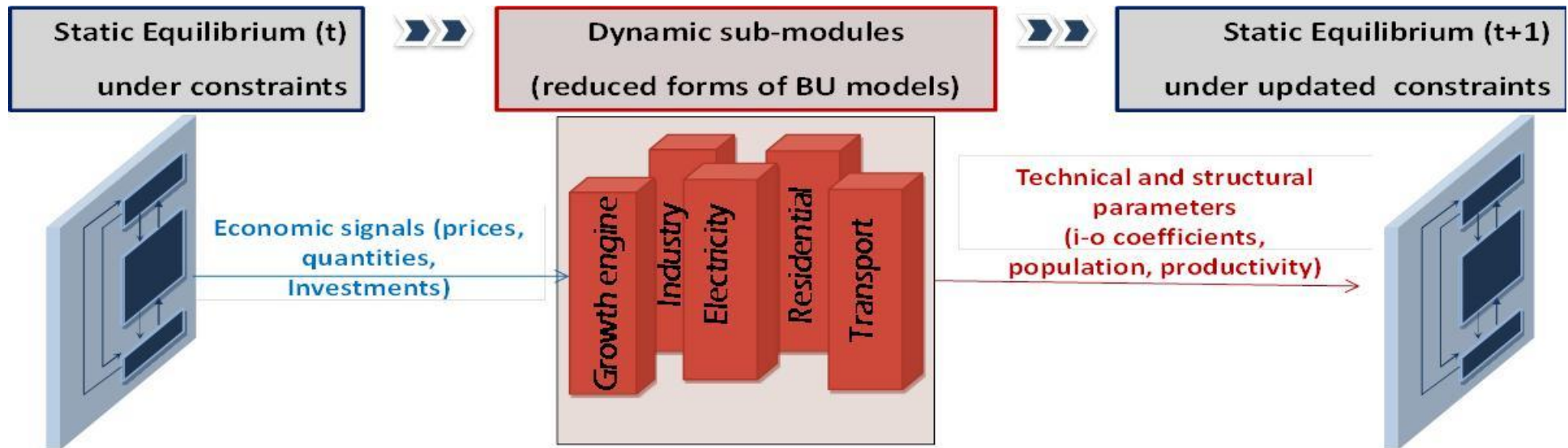
A *second-best* modeling framework

A long-term analysis approach to think the link between
growth, globalization, energy constraints

Given limited availability of fossil resources and carbon mitigation policies

The Imaclim-R model

multi-region and multi-sector Dynamic General Equilibrium



- **Annual** time step – Recursive succession of **top-down static equilibria** and **bottom-up dynamic modules**
- **Explicit** representation of **globalization drivers** both on **capital and trade flows**.
- Hybrid matrix: consistency between **money values and physical quantities**
(Calibrated on GTAP & IEA energy balances)
- **Second best** nature of economic interactions
→ market imperfections, partial use of production factors (e.g. unemployment)
- **Imperfect foresights** for investment decisions
- **Inertia** on technical systems

Specifications for International trade and Capital flows

- **Armington elasticities** \longrightarrow Alternative visions of trade globalization
 - High value (G+): **High substitutability** between goods produced in different regions
Pursuing of current trends of international trade
(intense competition/important export-import flows in all regions)
 - Low value (G-) : **Preference for local goods**
Slowing down of international trade
(re-regionalization of production: close to demand markets)

- **Regional Capital flows** \longrightarrow Alternative visions of capital globalization
(balance of payments)
 - A constant-over-time share of exported capital (K+)
Pursuing of current international capital imbalances
 - An exponential decrease of all capital flows (K-)
Progressive correction of international capital imbalances by 2050
Fragmented capital markets
Financing local investments with local capital

Specifications for International trade and Capital flows

The combination of these assumptions \longrightarrow 4 scenarios
(different future globalization patterns)

Benchmark case
Pursuing of current trends

		Assumption on good markets	
		G+	G-
Assumption on capital markets	K+	Continued Globalization	Regionalized Trade
	K-	Fragmented Capital	De-Globalization

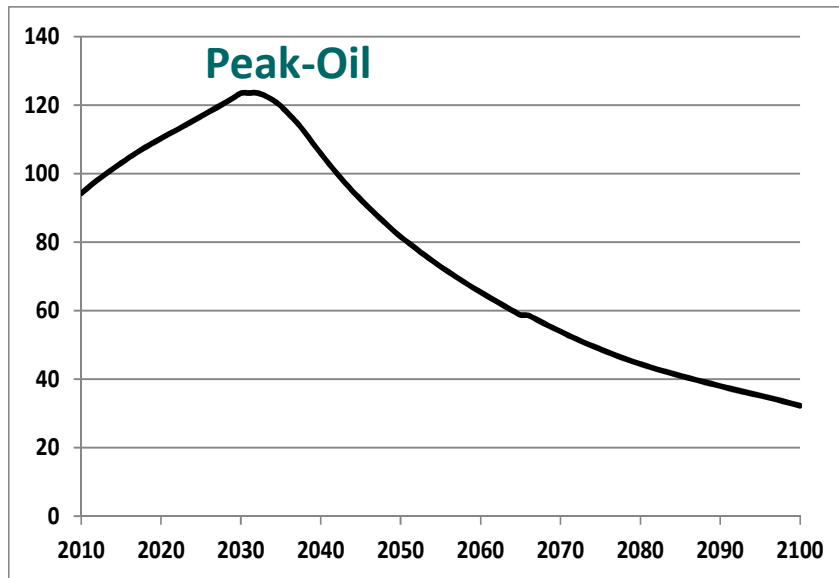


3 scenarios

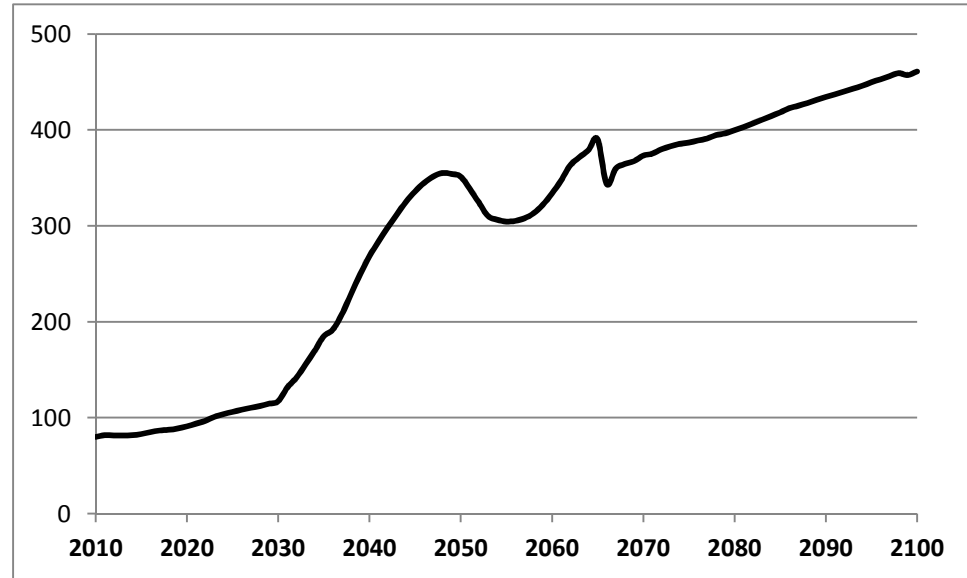
Combination of fragmentation assumptions
 \rightarrow
Results are systematically
Combination/Mix of the effects

Dynamics of oil markets (benchmark scenario)

World oil production
(Million bbl/d)

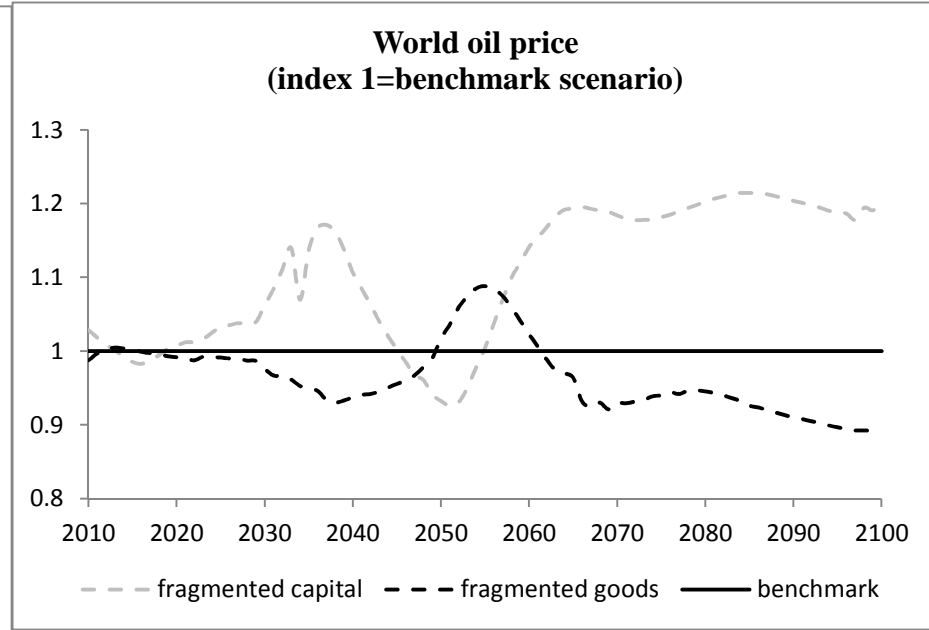
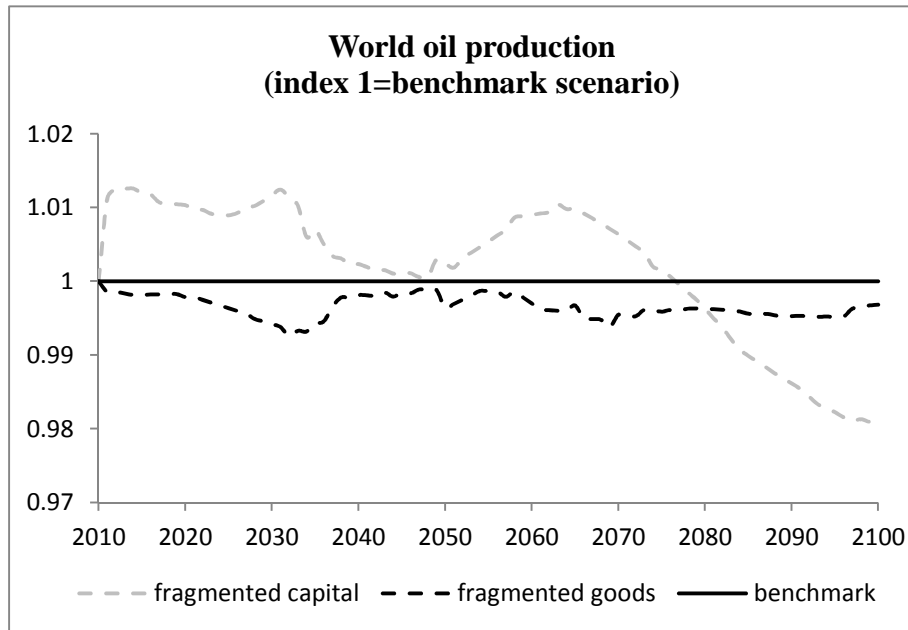


World oil price
(\$/bbl)



- **Oil production:**
Endogenously calculated
Follows an inverted-U shape reaching a maximum around 2030
- **Oil prices:**
Slightly increasing plateau
Sudden increase at the moment of **Peak-Oil** (2030)
Continuous augmentation as **the economy remains oil dependent**

Globalization processes & Dynamics of oil markets



- **‘Regionalized trade’ scenario**

Increased preference for local goods

→ a reduction of international trade

→ a moderation of oil demand (a lower dependence on fuels for transportation activities)

→ around 10% lower oil prices in the long-term.

- **‘Fragmented Capital’ scenario**

Less capital fluidity (at the global level)

→ slows down the pace of technical change

→ higher dependence on oil

→ strong increase of oil prices after the peak-oil and a long-term level 20%

Impacts on the chinese economy (benchmark case)

- The consequences of the sustainability challenge posed by tensions of oil markets on the stability of the Chinese socio-economic trajectories
- We compare the effective growth rate of the Chinese economy with its 'natural growth' rate
- The natural growth rate = Population's growth + Labor productivity growth

The growth of the economy if considering
one sector and full employment of production factors
(e.g. standard Solow model)

BUT:

{ Market imperfections
{ Imperfect foresights (→ Suboptimal allocation decisions)

Transitory disequilibria
(Effective growth \neq Natural growth)

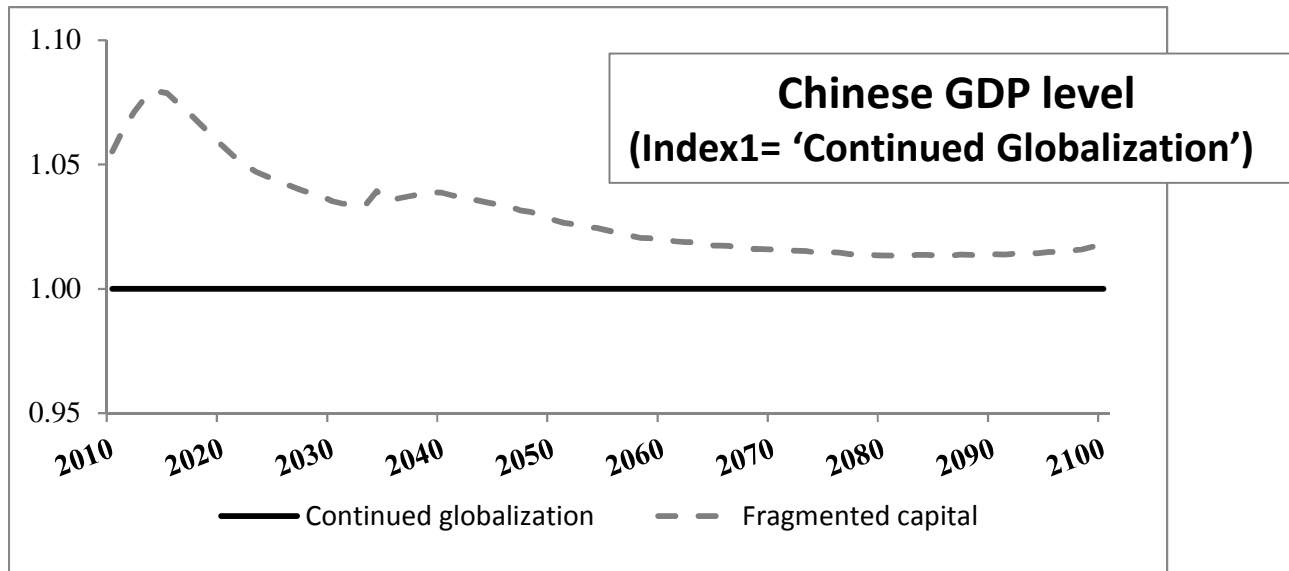
Impacts on the chinese economy (benchmark case)

Chinese Growth rates in the 'Continued Globalization' scenario

	2010-2100	2010-2030	2030-2040	2040-2050	2050-2100
Effective growth rate	2.67%	6.82%	2.52%	2.43%	1.13%
Natural growth rate	2.98%	7.52%	3.31%	1.86%	1.38%

- China, as a major oil importer and very energy-intensive
→ particularly vulnerable to FF price variations.
- The Chinese economy experiences long periods of unsustainable trajectories
On average over the whole century, The effective growth rate < The natural growth
→ Particularly important gaps in the post Peak Oil period and in the very long-term.
→ The long-term socio-economic tensions → Transportation sector
(high oil and coal prices + significant access to FF intensive road-based mobility)

Globalization processes & impacts on the Chinese economy



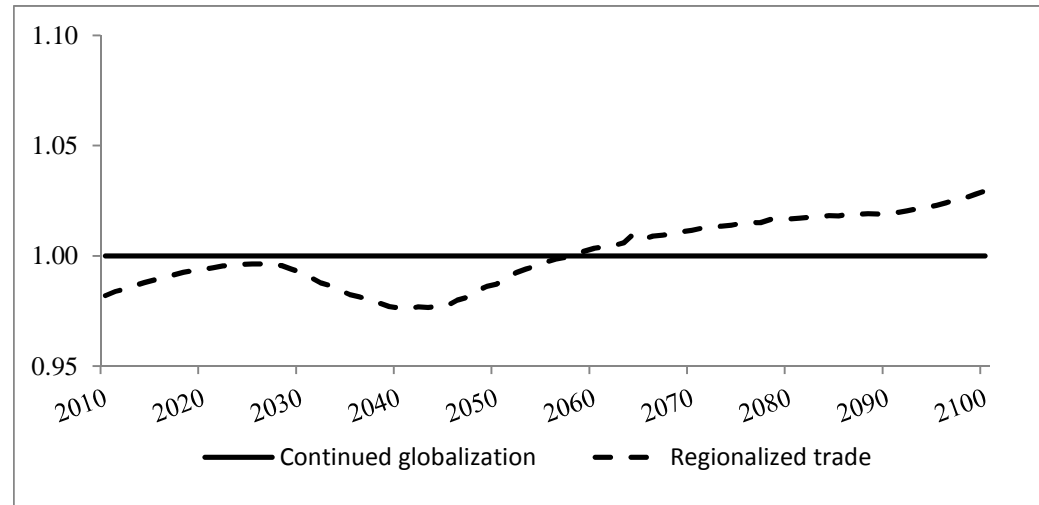
The fragmentation of capital markets

Positive effect on the Chinese economy during the whole century

- China is a net capital exporter
- Capital fragmentation releases capital for local investment in production capacities
- Helps to face rising oil prices

Globalization processes & impacts on the chinese economy

Chinese GDP level
(Index1= 'Continued Globalization')



The regionalization of good markets

Negative effect on the short-term

- Preference for local goods (for all regions)
- Reduction of the Chinese exportations
- Drop of the production, increase of unemployment, lower wages, lower demand

Positive effect on the long-term

- Lower oil prices
- Helps the development of local production capacities to satisfy local demand
(Production costs decrease enhancing household's purchase power)
- Offsets the effect of the exportations' reduction

Transition to low carbon society

- We now investigate the **sustainability challenge** posed to China by **climate change**
- We introduce a **global climate mitigation policy** (carbon pricing)
- The climate objective considered represents a limitation of the temperature increase wrt. pre-industrial levels to **2.5°C**
- We prescribe an exogenous global CO₂emission trajectory
- Each year, a **global carbon price** is endogenously calculated to curve carbon emissions

At the global level:

→ The global mitigation policy significantly moderates FF production patterns

It avoids the critical depletion experienced in the baseline scenario

(18% of 2001 oil reserves remain in the soil in 2100 vs. 6% in absence of climate policy)

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

Macroeconomic effects of climate policies on China

Maintaining the global temperature at an “acceptable” level

→ not neutral for the economic sustainability of China

	2010-2100	2010-2030	2030-2040	2040-2050	2050-2100
Effective Growth rate Climate stabilization at +2.5°C	2.51%	6.15%	3.13%	2.59%	0.96%
Effective growth rate Baseline scenario	2.67%	6.82%	2.52%	2.43%	1.13%
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- **Short term:**

Imperfect expectations + Inertia

→ High carbon price
(redirection of investments)
→ High production costs

→ Impacts the carbon-intensive Chinese economy

→ Increases of the gap btw natural and effective growth

Macroeconomic effects of climate policies on China

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- **Medium term:**

- The climate policy triggers much faster economic growth
- Co-benefit of low-carbon measures
- Foster a decreased oil dependency + Decrease of the carbon price
- Reduction of the gap btw natural and effective growth (the post-Peak oil period)

Macroeconomic effects of climate policies on China

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- **Long term**

- **A long-lasting socio-economic crisis**

- Significant increase of gap with the natural rate

- High carbon prices

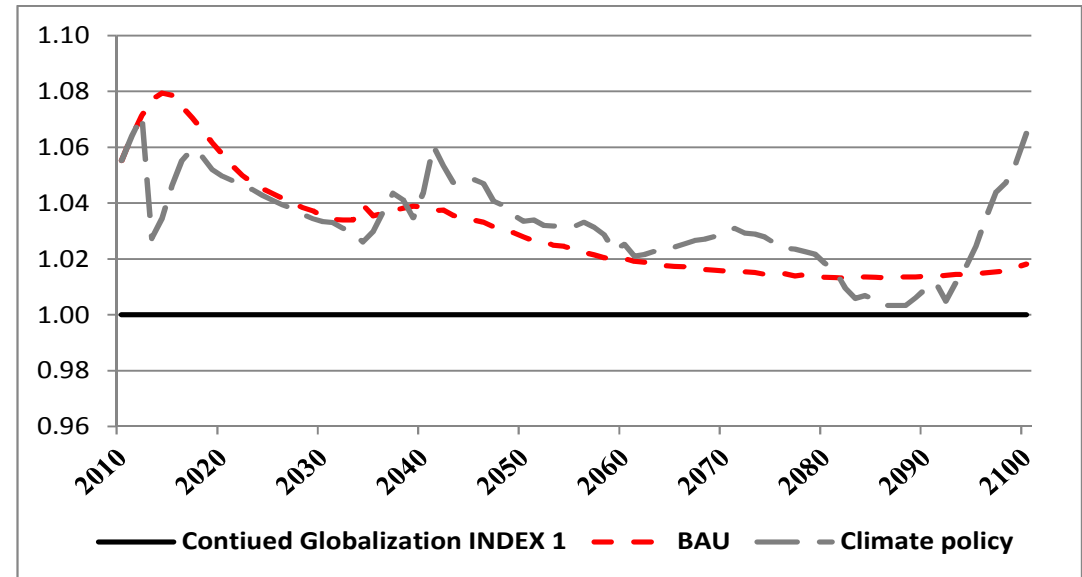
- Weak sensitivity of transportation sector to price signals

- (Transport infrastructure inertia + High mobility needs)

Climate policies & Globalization processes Impacts on the Chinese economy

Chinese GDP level
(Index1= 'Continued Globalization')

➤ Fragmented capital scenario



On the short to medium term:

In a “Fragmented Capital” world, China is more hurt by a global carbon pricing policy than in a “Continued Globalized” world

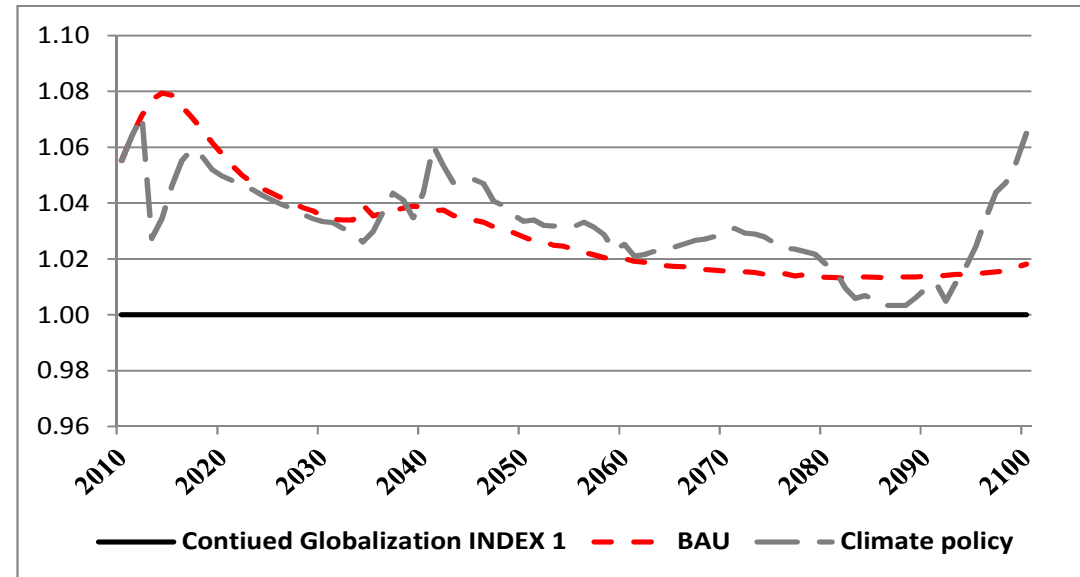
Less capital fluidity at the global level hampers the pace of technology diffusion between regions

Affects particularly the Chinese economy and slows down its growth considerably

Climate policies & Globalization processes Impacts on the chinese economy

Chinese GDP level
(Index1= 'Continued Globalization')

➤ Fragmented capital scenario



On the longer term:

China is less hurt by the climate policy in the fragmented capital scenario than in the continued globalization

The Chinese economy has adjusted + Higher availability of capitals in China for investments in new production capacities

→ Helps to face rising carbon prices

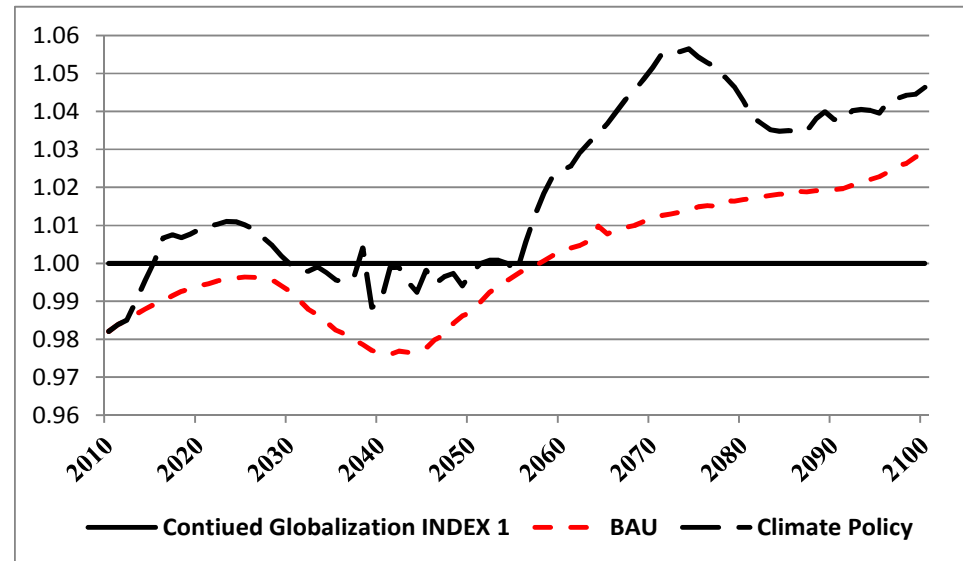
Climate policies & Globalization processes

Impacts on the Chinese economy

Chinese GDP level
(Index1= 'Continued Globalization')

- **Regionalization of good markets**
Beneficial over the whole period

On the short to medium term:



The Chinese economy is less affected by a climate policy when the world is regionalized in terms of good markets than in a more globalized world.

The carbon pricing policy → Variations in the prices' competitiveness of goods

The smaller the Armington elasticities are → the less sensitive are the exportations to the variations of prices

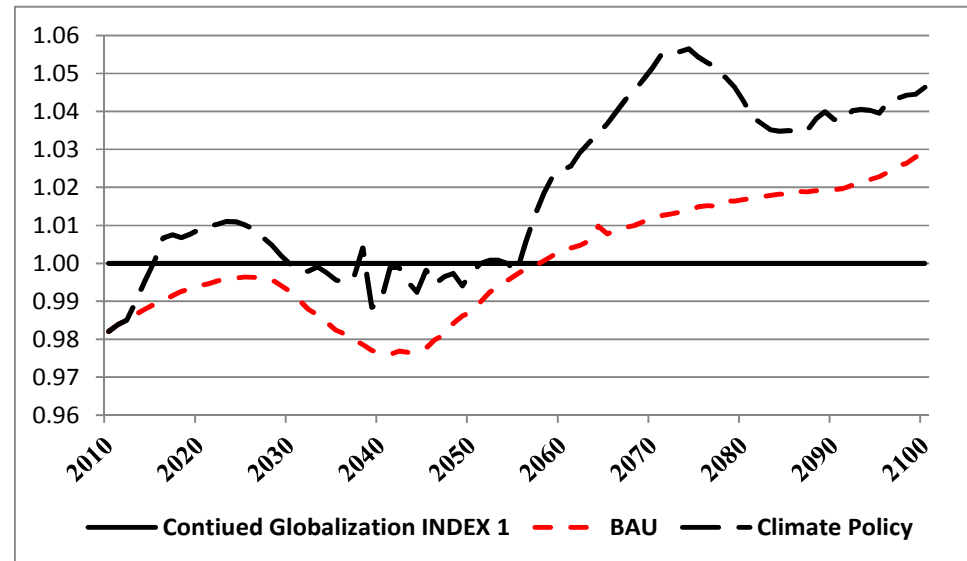
The reduction of exportations (due to the climate policy) is thus less significant than with higher Armington elasticities (i.e. in a more globalized world).

Climate policies & Globalization processes Impacts on the Chinese economy

Chinese GDP level
(Index1= 'Continued Globalization')

➤ Regionalization of good markets

On the long term:



The regionalization of trade triggers a significant better situation

→ Similarly to the case without climate policy

The lower reliance on international transport reduces the oil dependency of the economy and generates a higher GDP

+ Decrease of global oil demand → a lower carbon price than in the 'Continuous Globalization' one (e.g. 970 \$/tCO₂ vs. 1050 \$/tCO₂ in 2070)
a less hurt Chinese economy.

Conclusion

- Globalization processes are not neutral for the Chinese economy.
- However, the different assumptions on globalization, with or without climate constraint, do not modify the long-lasting crisis relative to the transportation sector
 - Due to the significant increase of the Chinese population that gains access to fossil fuels road-based mobility.
- Global price signals
 - May not be suitable to provide “correct” information on future energy conditions
 - May favor “wrong” allocation of investments hampering growth and welfare.
- They can be a useful tool to frame the Chinese transition towards a sustainable energy future
- But if they are used alone, they may entail significant socio-economic costs

Conclusion

- To make the double sustainability challenge posed by oil depletion and climate change viable and acceptable for China:
- Considering complementary non-pricing measures in addition to current market prices
As investment incentives that incorporate long-term views on resources and climate through a strong political will (e.g. fiscal reforms and sectoral/infrastructure policies).



Thank you for your attention!

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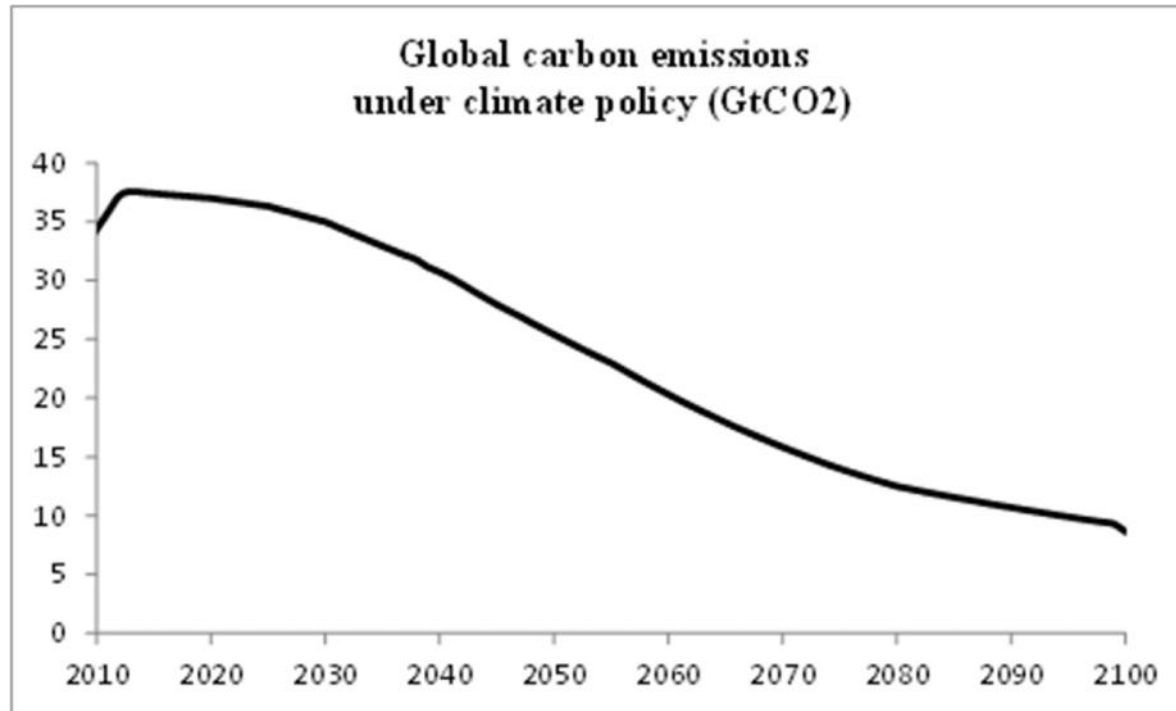
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Appendix

Specifications for international trade and capital flows

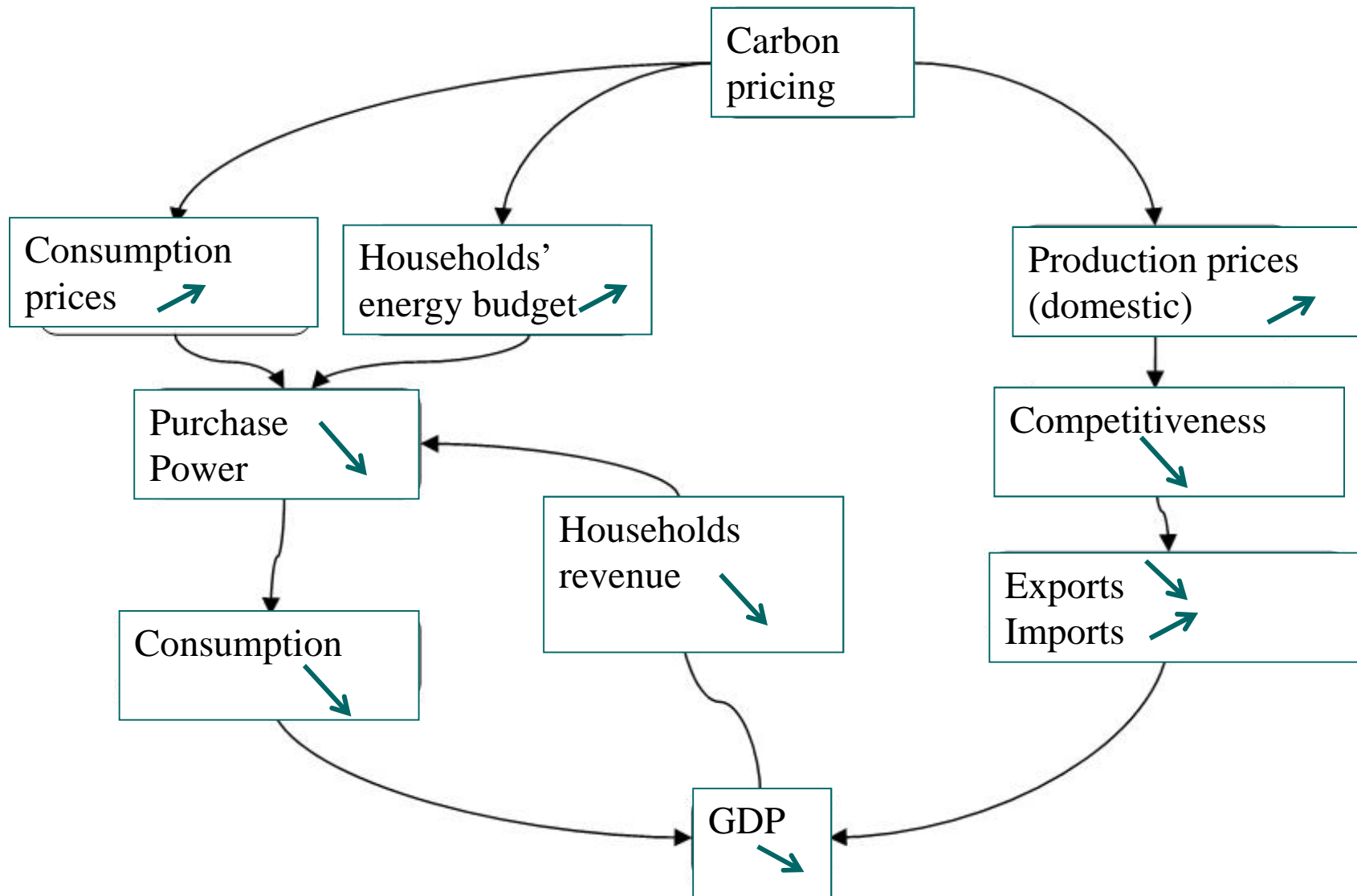
- All intermediate and final goods are **internationally tradable**
- The total **demand** for each good is satisfied by a mix **of domestic production and imports**.
- Trade flows are represented **in physical quantities for energy flows** (MToe)
- Whereas all other goods are described with **Armington specifications** (capture imperfect substitutability among goods produced in different regions)
- No stock is allowed : Domestic and International markets for all goods are cleared by a unique set of endogenous relative prices
- The prices adjust to maintain the equilibrium of the **balance of payments** defined by the **sum of trade flows and capital flows**.

Transition to low carbon society

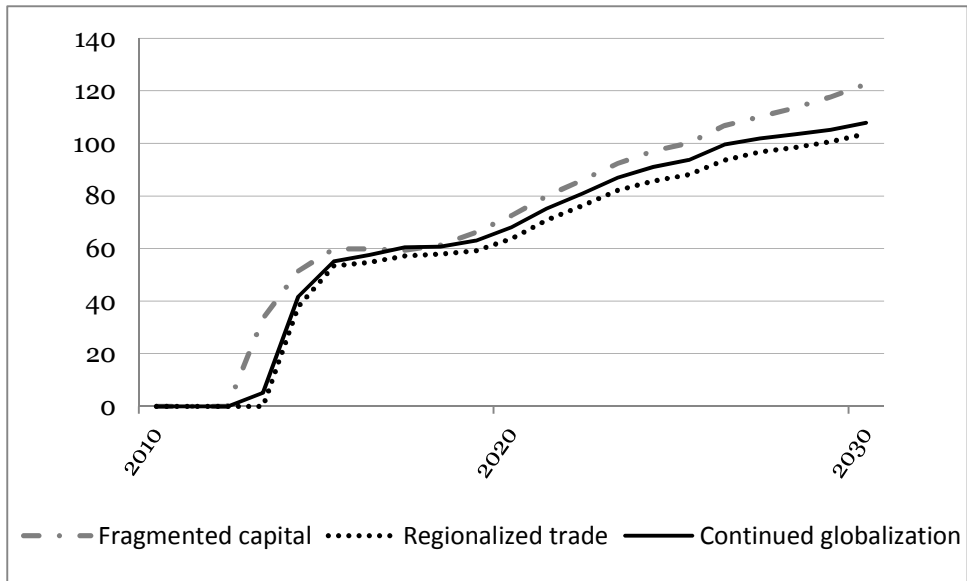


- The climate objective considered represents a limitation of the temperature increase wrt pre-industrial levels to 2.5°C
- We prescribe an exogenous global CO₂ emission trajectory
- Each year, a global carbon price is endogenously calculated to curve carbon emissions

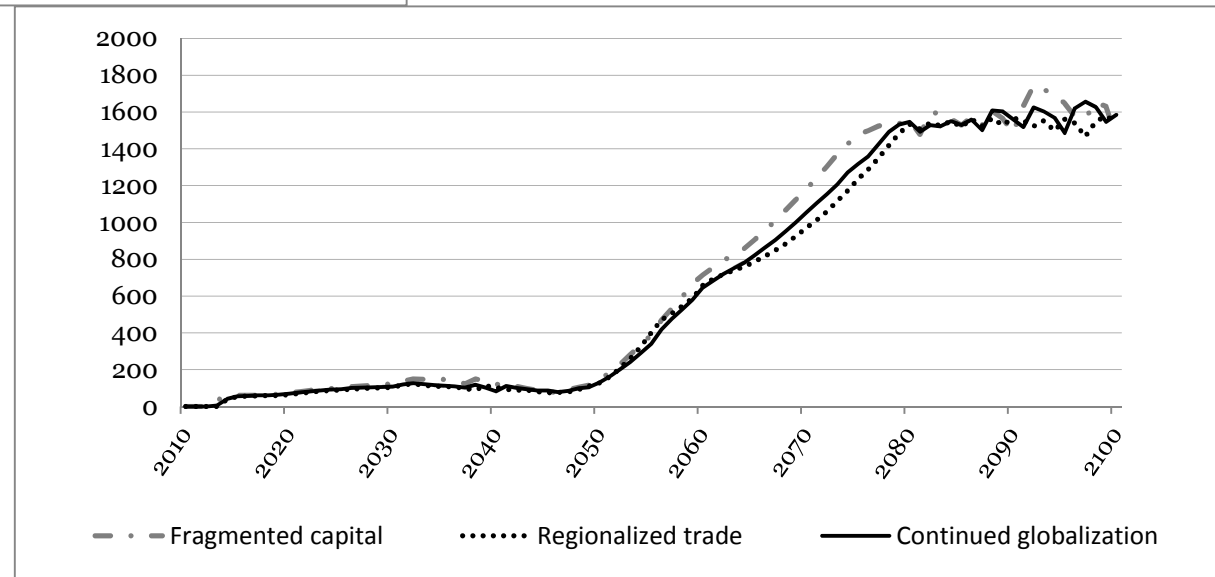
How carbon price acts on the economy



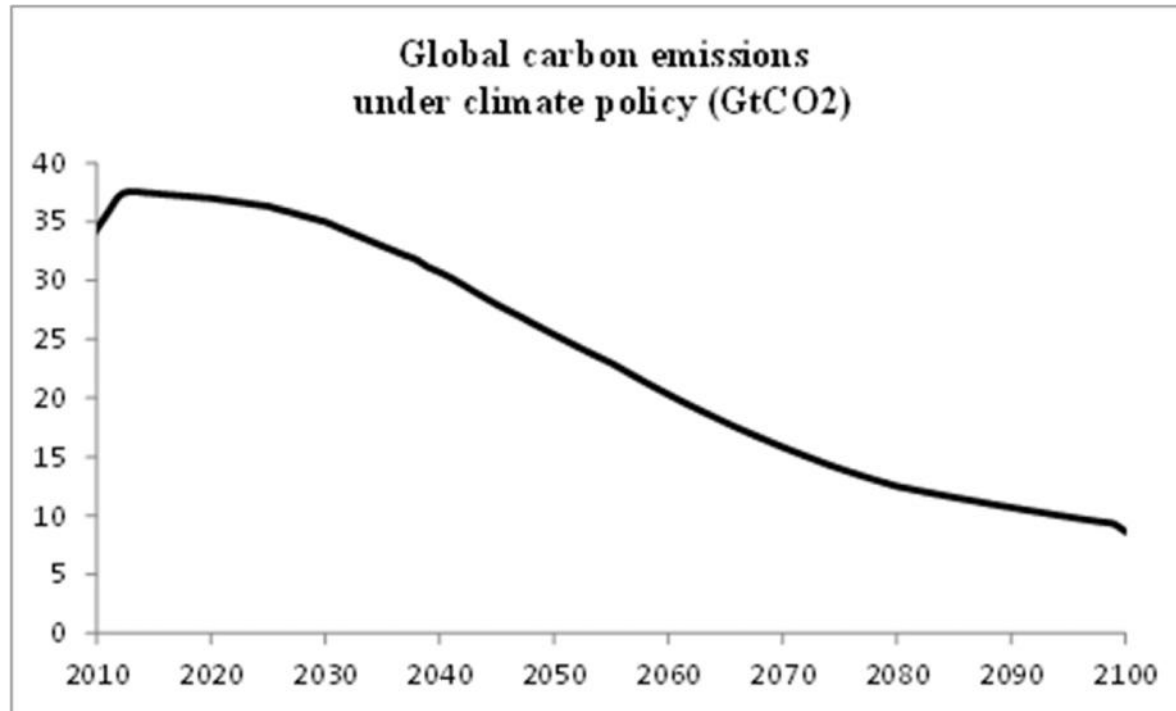
Carbon prices



\$/tCO₂



Transition to low carbon society

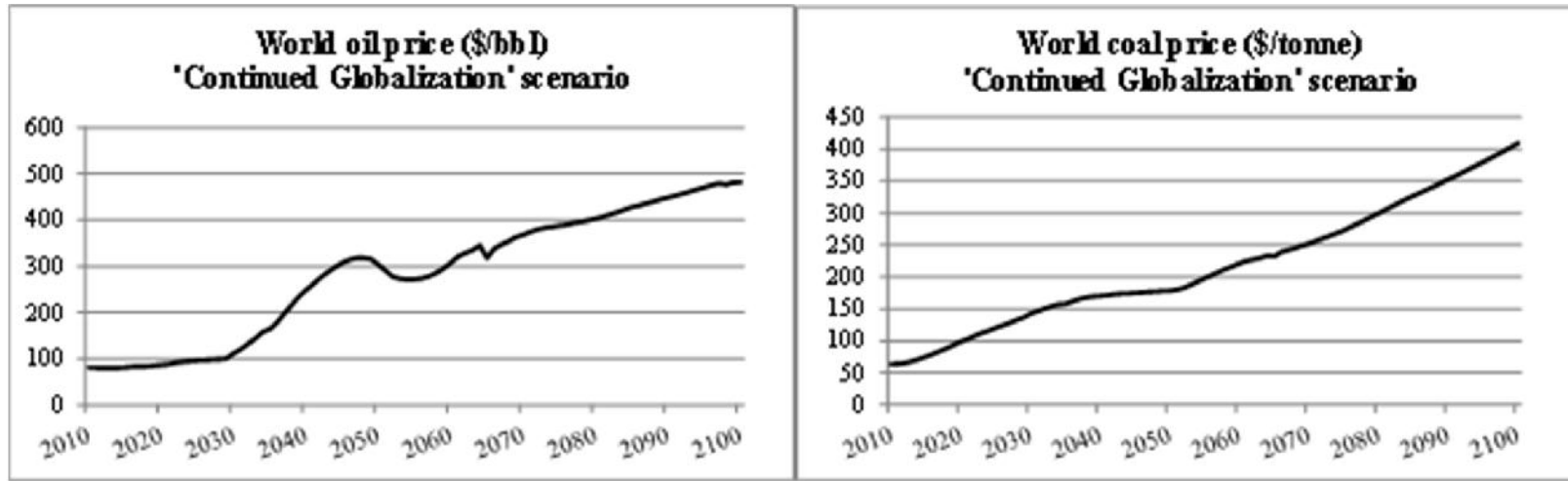


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Dynamics of oil market

- Oil markets dynamics are represented through the explicit description of geopolitical, technical and economic determinants on supply and demand side
 - Amount of reserves
 - Geological inertias
 - Short-term prices targeted by Middle-East producers.

Dynamics of oil and coal markets (benchmark scenario)



- **Oil prices:**

Slightly increasing plateau

Sudden increase at the moment of **Peak-Oil** (2030)

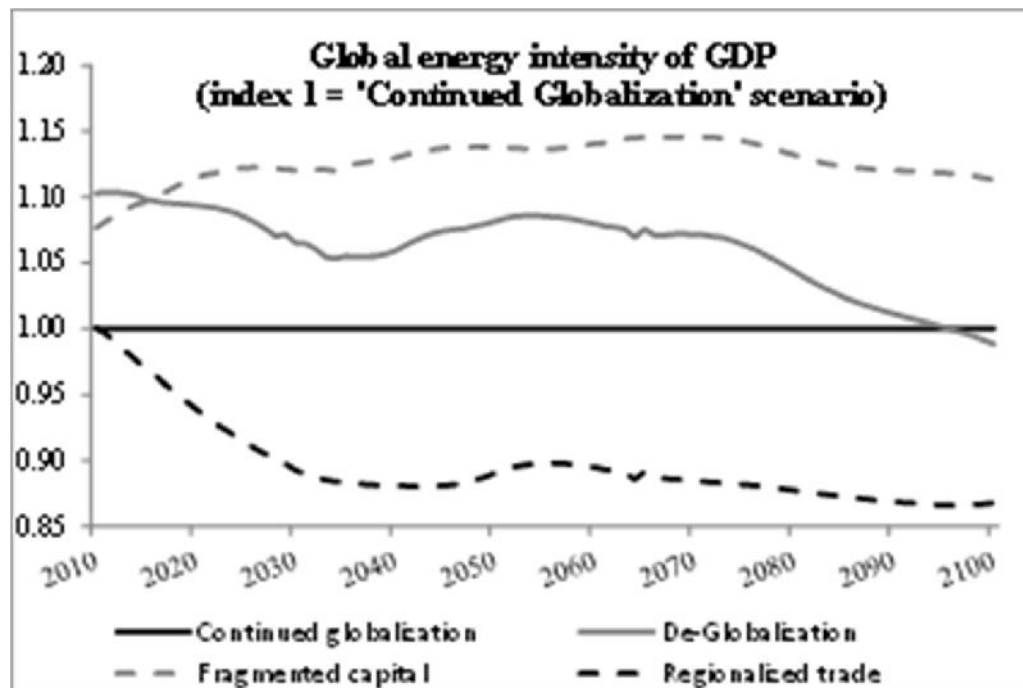
Continuous augmentation (500\$/bbl in 2100)

- **Coal prices:**

Continuous increase of the production → increase of the price

Globalization processes & Dynamics of oil market

- Global energy intensity of GDP to illustrate that in regionalized trade it decreases due to less intense reliance of the economies on fuels for their transportation activities



The natural growth rate

- The natural growth rate of an economy is given by the sum of population and labor productivity growths. It corresponds to the growth rate that an economy would follow if considering a unique sector and full employment of production factors, like for instance in the standard Solow model. **This indicator allows assessing the sustainability of growth patterns in the sense that an effective growth that is lower than its natural rate is the sign that constraints affect the economy.** They prevent from exploiting all the productivity potentials, causing unemployment, losses of purchase power and a decrease of production. The natural growth captures indeed the impossibility of the economy to absorb the total labor force at constant wages, due to particularly important adaptation difficulties in sectors where the growth is low.

Impacts on the chinese economy (benchmark case)

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Time profile of Chinese growth rates defines four major periods over 2010-2100:

- (i) A first period (2010-2030), where although oil prices are moderate, the growth is lower than its natural rate due to the significant increase of coal prices.
- (ii) A deep economic crisis consecutive to peak oil Peak Oil (2030-2040) during which a surge in oil price divides growth rates by three
- (iii) An important recovery phase (2040-2050) fostering a post crisis catch-up, in the sense that the effective growth is 30% higher than the natural one. This catch-up happens thanks to the adaptation of the economy to high oil prices
- (iv) Finally a long-term regime (2050-2100) in which the Chinese economy experiences particularly low growth rates (20% lower than natural levels). This is due to issues related to the transportation sector. During this period indeed, where oil and coal prices are very high, an important fraction of the Chinese population gains access to fossil fuels intensive road-based mobility.