Imaclim-R: Modeling transitions towards Sustainable Development pathways in a 2nd best world
The integration problem: what would we like to represent?

Overall productivity

Demographics
Aging
Migrations

Savings rate
Capital flows

Globalisation vs fragmentation

Growth engine

Consumption patterns

Energy, food and housing markets

Technology and resources

Localisation

C

T

L

C.I.R.E.D.
The risk of the combinatory explosion and the endogenisation challenge

• Several ‘material content’ and social content of growth for the same GDP: what feedbacks between these contents and growth: -> perverse growth - > increasing share of savings to reproduce human and technical capital

A need to capture

• The evolution of consumers’ preferences in various ‘built environment

• Interplays between energy prices, land prices, real estate prices, labor prices and risk-weighed capital prices: impact on both technical choices, fossil fuels exhaustion and .... ‘scarcity rents’

• Interplays between short term dynamics and long term pathways (beyond the question of the postponement of climate policies)
  – For the regional growth dynamics (fragmented vs inclusive globalisation)
  – For technological transformation pathways

• Interplays between “business regimes” and investment decisions given a) sectorial regulatory regimes b) the state of the monetary and financial system
Huron’s intuition: hybridizing models in two senses

• **Back to the Arrow-Debreu axiomatic**: hybrid Social Accounting Matrixes in values and explicit quantities to secure the consistency of the engineering based and economically based analyses

• **Hybridizing** long run (**neo-classical colored**) models with short run (**Keynesian colored**) model:

  “At a five to ten year time scale, we have to piece things together as best as we can, and look for a hybrid model that will do the job”
  Solow 2000

• These **two dimensions are deeply intertwined** and impose to come back to unsettled issues in growth and development theory and models

• Basic feature: **Johansen** type production function (ex-ante $\neq$ ex-post)
The IMACLIM-R model
A recursive and modular architecture to study transition pathways

- Static Equilibrium (t) under constraints
- Dynamic sub-modules (reduced forms of BU models)
- Static Equilibrium (t+1) under updated constraints

- Economic signals (prices, quantities, investments)
- Technical and structural parameters (i-o coefficients, population, productivity)

- Calibration in 2001: GTAP + IEA energy balance + mobility statistics
- Trajectories in yearly steps through the succession of:
  - Annual static equilibrium = Equilibrium of quantity and money flows at each point of time under short-term constraints
  - Dynamic modules = Evolution of technical and structural constraints in function of economic signals + catch-up mechanisms

Real GDP - China

Real GDP - India

Billions of dollars (US2001)

Real GDP losses - China

Real GDP losses - India

Low Growth + energy frictions

High Growth + energy frictions
A « carbon price only regime » .... or the economics of the ‘cap & trade’ only framework

A time profile robust to uncertainty

(550ppm CO2-eq stabilisation scenarios, +3°C)

<table>
<thead>
<tr>
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<th>IPCC, 2007</th>
<th>Imaclim-R</th>
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<tr>
<td>2030</td>
<td>[0.2 – 2.5]</td>
<td>3.8 [1 – 9.5]</td>
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<tr>
<td>2050</td>
<td>Slighty negative - 4</td>
<td>2.5 [0.5 – 4]</td>
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Early transport infrastructure policies open room for long-run benefits of climate policies

(550ppm CO2-eq stabilisation scenarios, +3°C)
Fiscal policies (and ...) to smooth the transition

(550ppm CO2-eq stabilisation scenarios, +3°C)
Priorities: infrastructures, finance and labor markets

- Infrastructure investment at heart because they determine
  - The long term development patterns (C, T, L) and ‘preferences’
  - The contribution of climate policies to a) reshaping the current globalisation pattern (more inward oriented strategy (RR) and b) to supporting sustainable growth recovery

- Investment risks and long term financial intermediation: creation of ‘carbon assets’ to cut down risks on long term investments:
  - dropping the selection of technologies in function of their increasing merit order
  - Reorienting savings ... and trade/financial flows (the ‘US/China’ disequilibrium)

- Labour markets in a world with migrations and informal economies in perpetual reformation -> link with income distribution
Triggering transformation pathways in an adverse context

Short term vs Long term? Turning the question upside down to mobilize the ‘climate agnostic’ policy-makers

Post 2008: between instable growth and depression economics

- « Saving glut » and « Buridan’s Donkey » dilemma for investors
- Risks of depression vs risks of re-unleashing speculative bubbles
- Banking systems still fragile and in process of deleveraging
- Tensions due to a « currency cold war »

Low carbon finance: a good candidate for responding the Rajan Raghuran’s diagnosis (Fault Lines)

- To redirect savings towards infrastructure and industry
- To launch a more inward-oriented industrialisation strategy backed on robust social security systems
- A more resilient financial and monetary order
‘Low Carbon Finance’ and carbon pricing: endogenizing a ‘social value of avoided emission’ in an uncertain world.
On going works useful for TWI 2050

- with EDF (R&D) and IEA (june/july)
- with the DDPP project (june/july): starting from a ‘suboptimal baseline’ change the economic assessment of climate policies

- with CDC, France Stratégie, Cepii, IASS (Germany) BNP Paribas, Unep-Finance, World Bank (IFC) and others on the ‘financial intermediation and the “macrofinancial” dimension of the transition (with DSGE model)

- with the MAPS project (stakeholder dialogue in Brazil, Columbia, Perou, Chile) and collaboration with South Africa, India, China: focus on the development impact, labor markets and income distribution

See also


Can indebted Europe afford Climate Policy? Can it bail out its debt without Climate Policy? M Aglietta, JC Hourcade *Intereconomics* 47 (3), 81-87
IMACLIM, result from a Huron’s view in the early 90ies

• Coupling energy models with long run growth models **was (and is still)** the task to be done, but should not attract all the attention:

  “At short term scales, I think, something sort of ‘Keynesian’ is a good approximation, and surely better than anything straight ‘neoclassical’. At very long time scales, the interesting questions are best studied in a neoclassical framework and attention to the Keynesian side of things would be a minor distraction”  (Solow 2000)

• The BU/TD debate about the **energy efficiency gap** tends to mask **other sources of pre-existing sub-optimalities** (labor markets, real estate, infrastructures, informal economy) that may:
  – Be a potential for double-dividends of environmental policies
  – Exacerbate policy costs

• The **‘elephant and rabbit stew metaphor’** (Hogan & Manne 1977) holds only under conditions
  – Low departure from pre-existing baselines
  – No deep structural effects
Cheap 2K? Too good to be true?
(at the root of the US/EU game of distorting mirrors)

« The most ambitious pathways [350-450 ppm CO2] are possible » with a macroeconomic impact comprised between +0.5 and -3% of the GDP in 2030 with technologies currently known and a uniform carbon price between 5 and 80 $/tCO2 in 2030

... a good news subject to a ‘never read’ caveat:

‘Most models use a global least cost approach to mitigation portfolios and with universal emissions trading, assuming transparent markets, no transaction cost, and thus perfect implementation of mitigation measures throughout the 21st century.’ (AR4 WGIII SPM Box 3)

... to which one should add ‘and

And widespread benevolence to compensate the loosers
Three risky but necessary methodological attempts

- Representing **adaptive behaviors** instead of perfect (or myopic) foresight

- **No** ex-ante prescription of tractable (neo-classical) production functions

- Endogenous disequilibrium due to **the interplay between imperfect foresight, technical inertia and social routines** -> a touch of keynesianism under the general equilibrium constraints
The IMACLIM-R model
The annual static equilibrium
The IMACLIM-R model
The annual static equilibrium

- **Basic needs**: minimum viable level for essential goods (food, shelter)
- **Energy services**: energy demand derived from transport activity (km) and residential uses (stock of m²)
- **Transport**: Capacity by mode (congestion) + Time budget
The IMACLIM-R model
The annual static equilibrium

- **Fixed technology in the ST:**
  - Leontieff specifications
  - Production capacity (max production level)

- **Partial use of production factors**
  - Unemployment (wage-curve)
  - Idle capacities

- **Imperfect marjets**
  - Margin rate over marginal costs
The IMACLIM-R model
The annual static equilibrium

Households
Utility function

Production sectors
Under ST constraint (capacity +technologies)

Public administrations
Redistribution & Infrastructures

Transfers

prices
wages

Final demand

Taxes

Exportations

Importations

World markets of capital and goods

Taxes

• Endogenous trade balance :
  o Armington specifications for non-energy goods
  o Terms-of-trade adjustments
• Exogenous capital flows
• Equilibrated balance of payments
Consistent accounting matrixes

- Economic balances
- Energy balances
- Material balances
- Land-use balances

Putting these four accounting systems consistent narrows the set of plausible coefficients

Allows for incorporating ‘non statistically standardized’ information (a common practice for climate modelers to recuperate ‘missing information’): “To believe that empirical economics begins and ends with time-series analysis is to ignore a lot of valuable information that cannot be put into so convenient a form. I include the sort of information that is encapsulated in the qualitative inferences made by expert observers ....” Solow 1988
At the roots of the « bad news »

**Significant short-term losses:**

- **Inertia** in installed capital and **imperfect foresight** limit the pace of decarbonization, and requires high carbon prices
- **Increased production costs** transmitted to consumers
- Inertia in changing households equipment reinforces the **loss of purchasing power**
- **Macroeconomic feedbacks** (unemployment, lower wages, lower consumption...)

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**Long-term losses:**

- **Inertia of infrastructures, location choices, urban forms**
- **Rebound effect of mobility needs** requires very high carbon prices in the second half of the century

At the roots of the « bad news »
Compensatory transfers for a ‘fair’ burden sharing?

- **Unrealistic amounts** (direct or through quotas allocation) to equate welfare losses, e.g. in 2030:
  
  - Africa: +8% of GDP
  - India: +6% of GDP
  - CIS: -4% of GDP (better-off thanks to gas exports)
  - Europe: -1.2% of GDP
  - USA: -1.7% of GDP

- Impossible to afford in an Overseas Development Aid perspective and in an **untimely context**
  
  - Financial crisis
  - Emerging countries are net capital exporters
  - Emerging economies perceived as threats for jobs, and getting a financial power capable to take control of significant parts of their industry
The basic economic wisdom of climate negotiations in question...

- Uniform carbon prices (only) policies are **squeezed**:
  
  - They **hurt emerging economies over the short run** (when the carbon prices are low relatively low)
  
  - Without preventing **risks of lock-in** in carbon intensive development pathways

- **Non negotiable « equity »** of the burden sharing and compensations

  *Thanks for the « fairness » but .... We don’t want the burden! ‘We do not want your money’*  
  Pdt Lula at Copenhagen
“Second best” – Good news?

Or new room for manoeuvre...
Aligning climate and development policies through a wider palette of signals

- **Upfront public and private investments** on buildings, urban infrastructures and long distance transportation

- Mobilizing **a wider set of price signals** (real estates, land)

- **Carbon prices cannot do the job alone .... Urgent to account for the whole set of relative prices!!**
The urban module

Step 1: The system of cities in interaction

- Urban description
  - Monocentric and axysymmetric
  - All firms settled in the a-spatial CBD
  - Workers/laborers:
    Agglomeration effects vs. urban costs (commuting and housing)
  - City-specific characteristics (productivity, commuting costs, amenities)

- Intercity description
  - Preference for variety imposes inter-city trade (iceberg form)
  - Consistency with national indicators: population, production, prices, wages
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- **Step 3: Reaggregation of parameters**
  - Transport basic needs, transport infrastructure investment needs, transport infrastructure capacities, productivity
Baseline urban dynamics

- **70 OECD cities** in 4 macro regions (USA, Canada, Europe, OECD Pacific)
  - OECD Metropolitan Database

- **Density trends**
  - A consequence of global macroeconomic trends (Fuel prices, Energy efficiency, Wealth) affecting transport costs and hence transport/housing tradeoffs

- **Urban land prices:**
  - A measure of competition for housing services: housing saturation in denser cities

![Graphs showing average city density and urban land price trends](image-url)
Climate policies and urban dynamics

Variations of **unitary commuting cost** under climate policy

Variations of city density under climate policy

Variations of carbon price under climate policy

CO\(_2\) emissions (GtCO\(_2\))

Carbon price ($/tC\(_2\))
Climate policies and urban dynamics

Variations of **unitary commuting cost** under climate policy

Variations of **city density** under climate policy

Variations of **urban land price** under climate policy
Complementary urban policy in climate policy

- Under a carbon tax only framework
  - Surplus losses: fast increase of carbon prices (mobility dependence)

![Graph showing OECD surplus variations under climate policy (Billion $)](image-url)
Complementary urban policy in climate policy

- Under a carbon tax only framework
  - Surplus losses: fast increase of carbon prices (mobility dependence)

- Urban policies as complementary measures to carbon prices
  - 0.1% of OECD GDP
  - Decreased constrained mobility

**OECD surplus variations under climate policy (Billion $)**
Introducing three important determinants of agglomeration effects in cities and of urban costs:

- **Housing supply**: promoters’s construction decisions in function of expected profits and housing demand
- **Transport congestion**: interplay between transport infrastructure, modal choice and the dynamics of real estate at the local level
- **Local labor markets**: unemployment rate, wages and production costs
Detailed calibration of transport modes (ex: Paris)

- Updated version of the model calibrated on France for a study funded by the French Ministry of Environment (CGDD-ADEME)
- Example of data used at a city scale