

Induced technical change in the transportation sector and induced mobility.

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Centre International de Recherche sur l'Environnement et le Développement, Paris.

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Why do emissions from transportation raise a specific long term policy challenge?

- Recent historical emissions show vigorous **upward trends**.
- After oil shocks, reactions show **low price elasticity** of final demand
- Gasoline from fossil fuels has a large **competitiveness margin**.
- How to bend transportation emissions implies to understand **complex dynamics** behind mobility needs.

Towards a broader view of the Induced Technical Change vs Autonomous Technical Change debate.

- Modeling **Technical Change as *induced*** by R&D, learning by doing and incentive systems is a way out of the representation of TC as a 'manna from heaven'
- But TC is not only a matter of production function unless it is assumed to be with no impact on **structural change** (lifestyles, dematerialization, land use patterns).
- This cannot be the case for transportation : mobility demand result from a non trivial **interplay** between
 - Consumption patterns,
 - Available technologies
 - Localization patterns

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- Including transportation demand dynamics in the IMACLIM-R model.
- Long term transportation scenario : baseline results.
 - Traffic volumes.
 - Modal shares.
- Long term transportation scenario : policy results.
 - Induced technical change and transportation emissions.
 - Induced mobility and transportation emissions.

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Stylised facts in transportation demand: when technical change impacts the level and structure of final demand

- **Rebound effect** due to energy efficiency improvement,
- **Demand induction** by transportation and urban infrastructures,
- Drivers of demand evolve over different **time scales**:
 - Infrastructures (decades)
 - Localization of production/consumption/housing/... (decades and sometimes one century)
 - Private equipments (a few years)
 - Energy prices (volatile), Real Estate prices

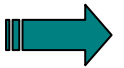
⇒ Inertia, 'lock-in', risks of maladjustments

Integrating transportation demand specifics in a long-term prospective exercise : principles

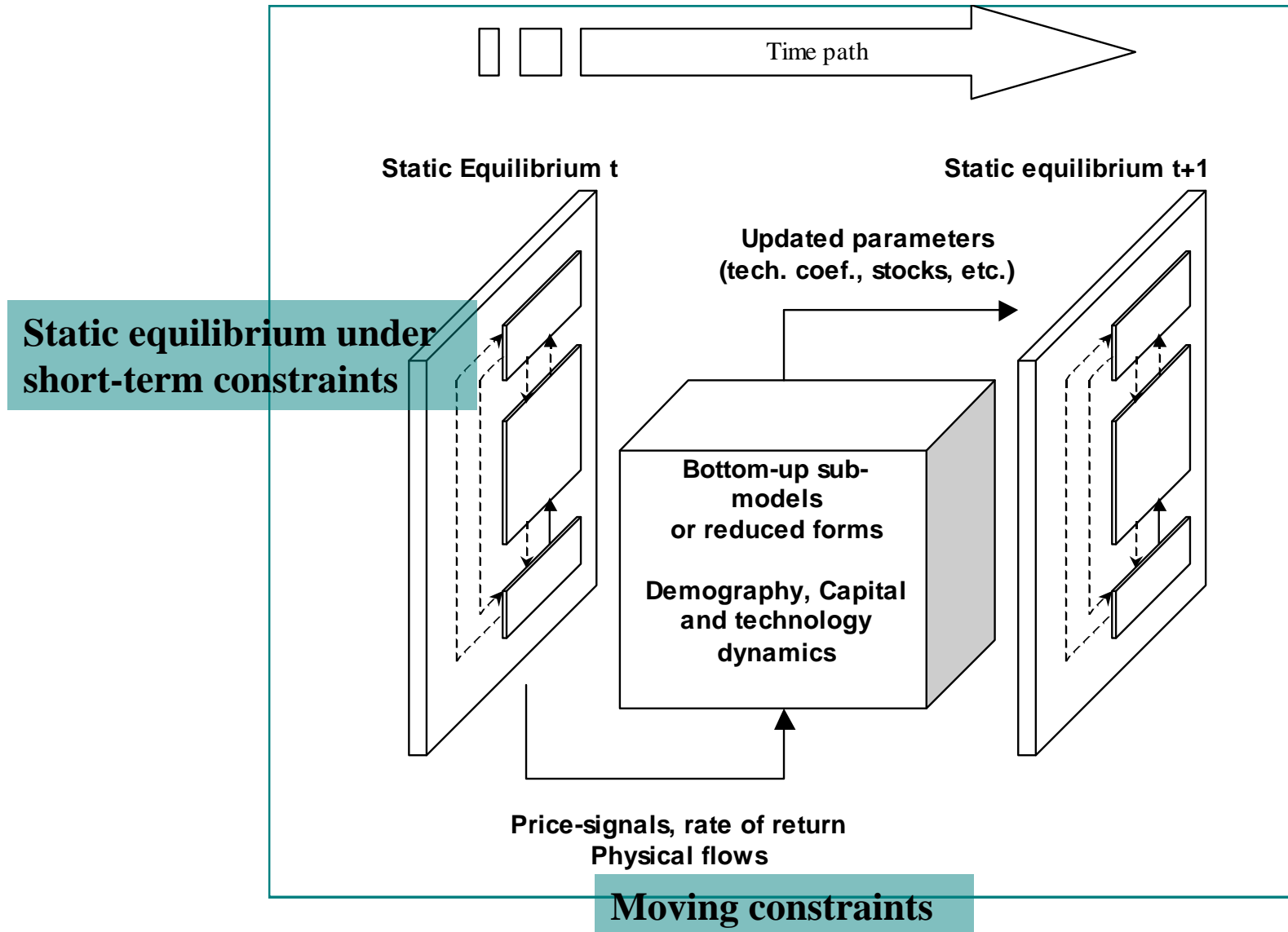
- Aim to disentangle **specific mechanisms** at play behind emissions dynamics and especially non-trivial interactions driving transportation patterns.
- Considering a **comprehensive architecture**, including a growth engine, general equilibrium consistency and technical information.
- Testing various trajectories due to different kind of **policies**.
- Recent ongoing works on this topic (Schäfer et al., Edmonds et al., WBCSD Mobility 2030...)

Salient features of the hybrid model IMACLIM-R

- IMACLIM-R is a LT growth model based on :
 - Succession of **static equilibriums** under short-term constraints
 - Allows for macroeconomic feedbacks on household consumption...
 - **Moving constraints** informed by reduced forms from BU models
 - Includes technological asymptotes, technological competition
- **Physical account** of energy (Mtoe) and transportation (PKT) consumption.
- Fossil fuel reserves and **endogenous price of oil**.
- **Investment in infrastructures** are governed by profit maximisation or by routine behaviours capturing various public decision styles.



Recursive structure of IMACLIM-R



Static equilibrium under short-term constraints

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Modeling short-term modal choice and mobility demand

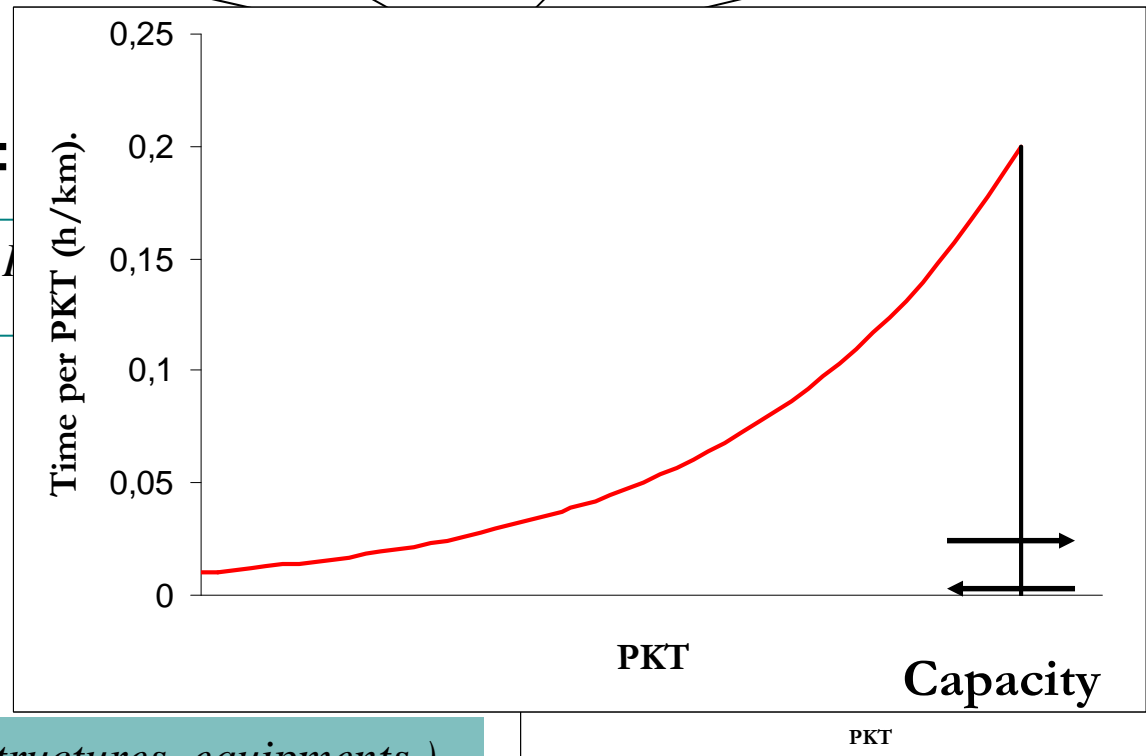
Utility maximization: $U = \prod (C_i - bn_i)^{\xi_i} (S_j - bn_j)^{\xi_j}$

With $S_{Mobility} = CES \left(PKT_{air}, PKT_{public}, PKT_{cars}, PKT_{non\ motorized} \right)$

Under two constraints:

$$Income = \sum_i p_i \cdot C_i + p_{public} \cdot A$$

$$Tdisp = \sum_{Modes T_j} \int_0^{PKT_{T_j}} \tau_j(u) du$$




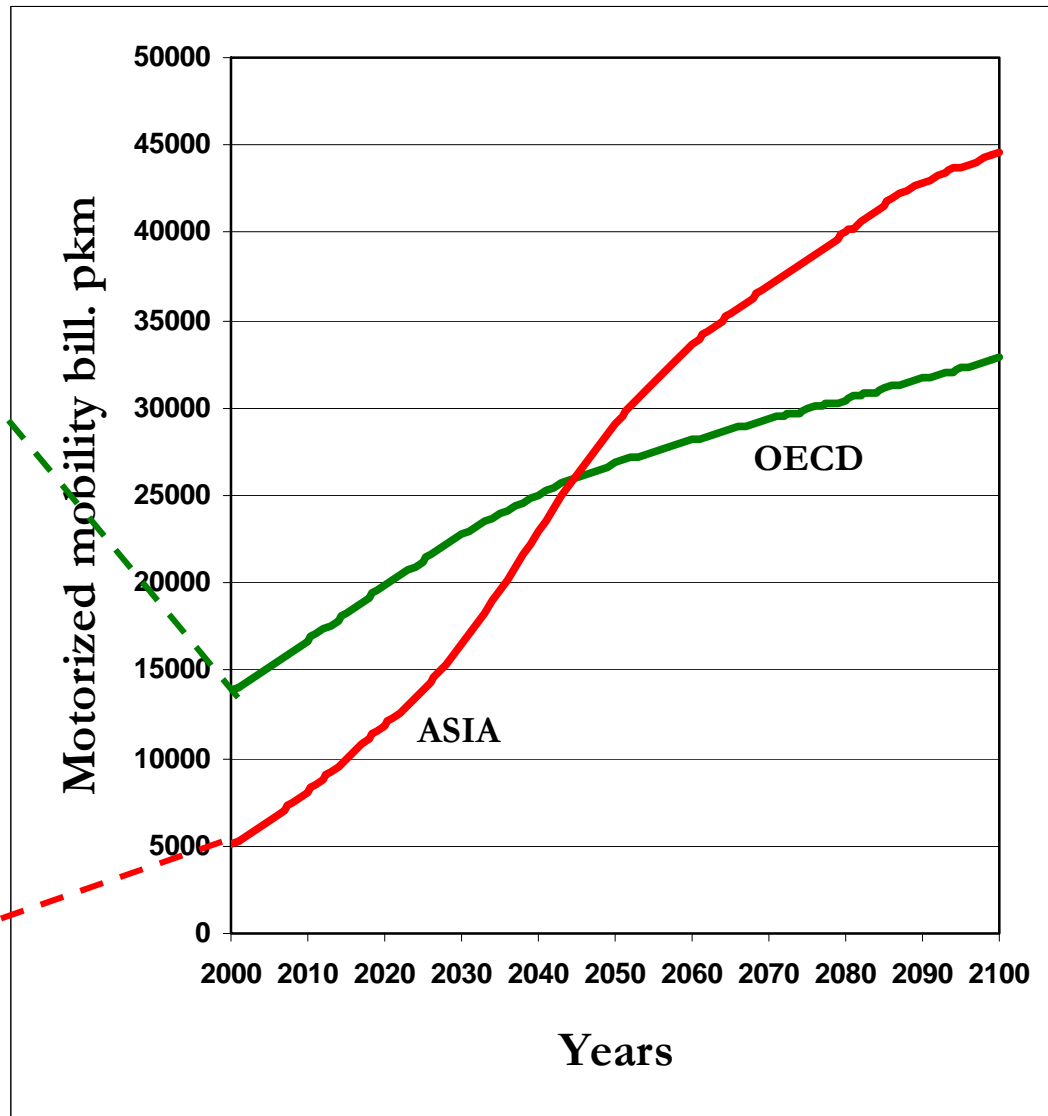
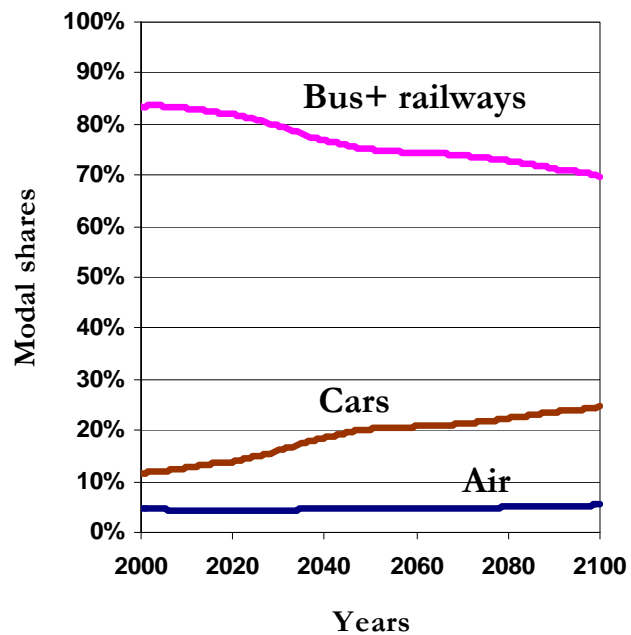
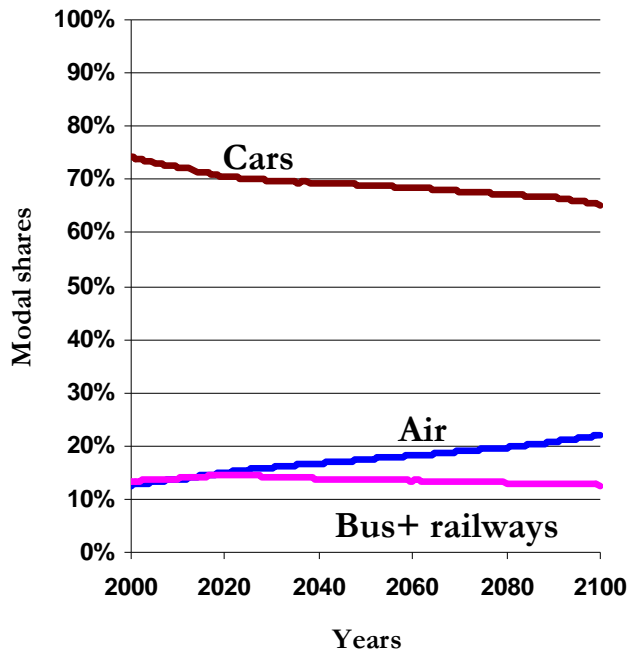
Capacity = function (infrastructures, equipments)

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Results: baseline scenario

- 5 regions (OECD, ASIA, REF, ALM, OPEC) – 10 sectors – from 2000 to 2100
 - Aggregate dynamics close to SRES A2 (medium growth - high emissions)
 - Pessimistic view of future carbon-free technology (no backstop)
 - Technical asymptote of energy efficiency gains in personal vehicles (x4)
 - Transportation dynamics:
 - Traffic volume.
 - Modal share.
- 
- As demand is completely endogenous, transportation growth can be constraint by fossil fuels scarcity.



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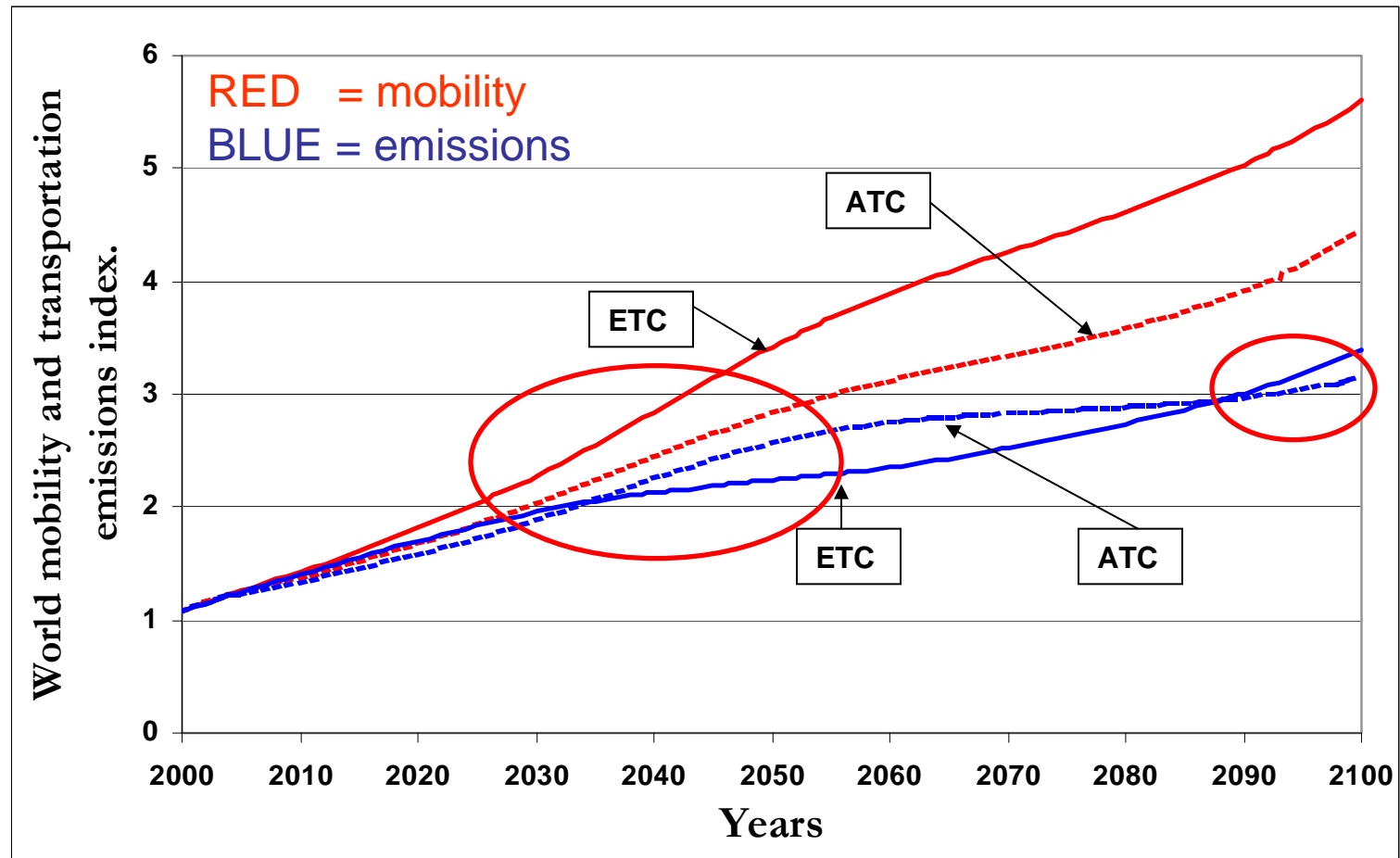
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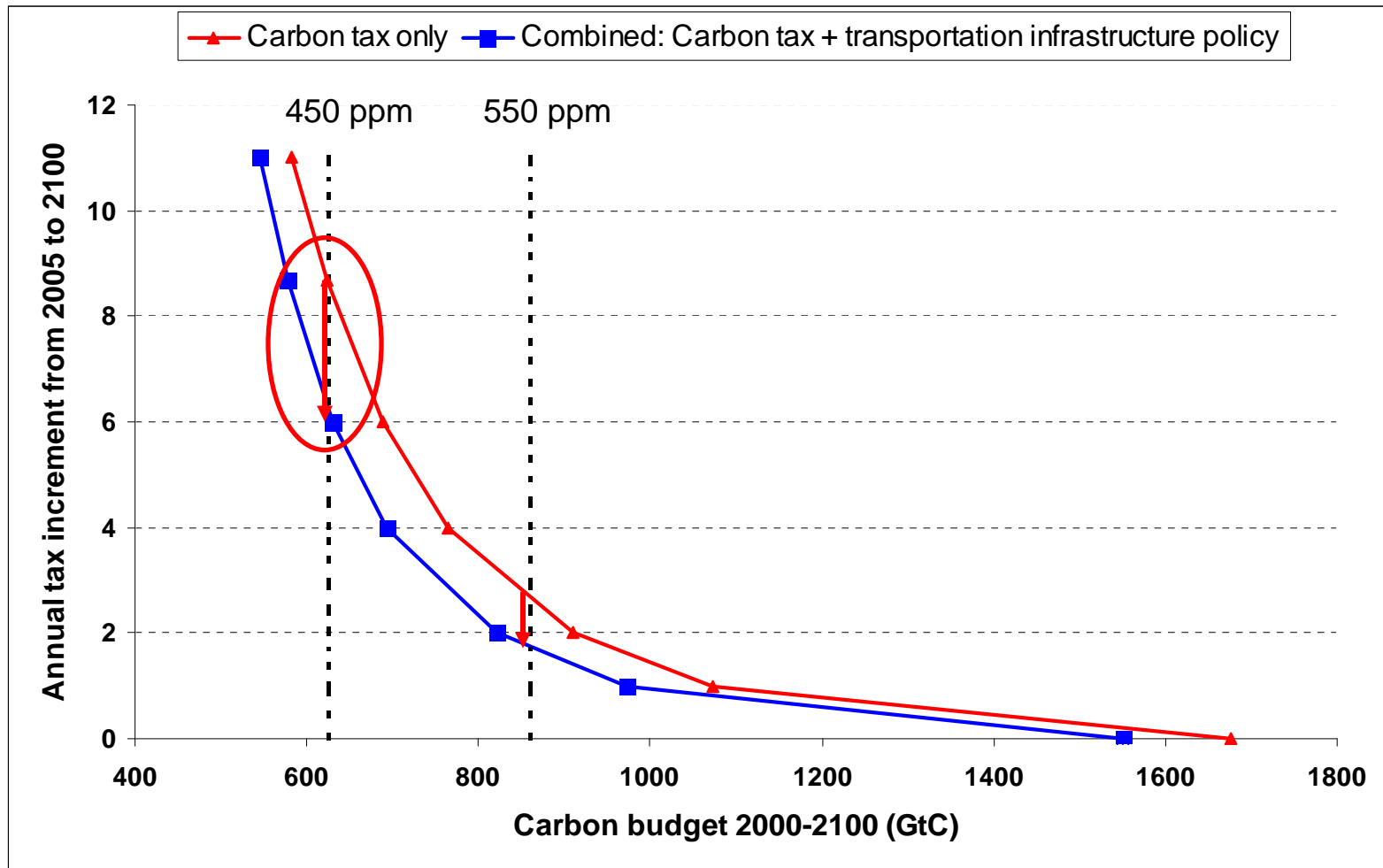
Results: Policy scenarios.

- Run under Autonomous or Endogenous technical change assumptions (ATC/ETC).
- Two stabilizations targets (450 ppm and 550 ppm) with tax only policies.
- Alternative policy scenarios combining tax and infrastructures policies.

Rebound effect on transportation : sectoral emissions.



Infrastructure policy lightens the required tax burden.



Conclusions and further works

- **Conclusions:**
 - Energy efficiency improvements in the transportation sector are partially off-set by an increase of total mobility.
 - Transportation emission mitigation needs for clear and consistent policy signals.
 - **Further works:**
 - Behind our hypothesis on infrastructure investment:
 - Real estate price dynamics.
 - Households localization choices.
 - Land use policies.
- ➡ Toward a more explicit spatial representation?

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