Urbanization and low-carbon growth pathways : Modeling the interactions between energy and real estate prices

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Session: *Domestic and international drivers of urban dynamics*

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This presentation proposes a framework for thinking the role of urban dynamics in the transition towards low-carbon societies.

The economic impacts arising from specific policy interventions aimed at CO2 abatement (mainly, carbon taxes/subsidies and emission trading permits) are conventionnally analyzed with multi-regional, multi-sectoral CGE frameworks. The development of those frameworks has been mostly oriented towards the representation of the energy sector with focuses on supply-side technologies, energy efficiency and structural change, and most energy-economy models consider carbon price as the only driver of decarbonizing economies. On the other hand, despite evidence of the specificities of the transportation sector (low price-elasticity but sensitivity to location decisions, spatial organization and infrastruicture availability), poor attention has been devoted to the representation of location patterns and non-energy drivers of mitigation costs.

Overcoming these limitations and representing the role of the spatial organization of the economy in long-term growth patterns raise number of methodological issues: *i)* capturing the features of second- best worlds with imperfect foresight, inertia of capital stocks, market imperfections (underutilization of production factors); *ii)* representing structural change driving the decoupling between growth and energy beyond pure energy efficiency as a consequence of the interplay between consumption styles (preferences), technical potentials (resource and technology availability, asymptotes) and location patterns; *iii)* capturing the interplay between energy prices, land prices and the growth engine (productivity, demography, savings) in an opened economy; *iv)* endogenizing the urbanization process and location decisions in urban/rural areas.

This is done by enabling the dialogue between the general equilibrium framework Imaclim-R and a model of systems of cities in interaction. The former has been developed at CIRED for the analysis of long-term energy and climate futures in second-best worlds. It adopts dynamic

recursive architecture, a dual accounting of energy and transport flows in physical quantities and money values, and embarks bottom-up expertise through reduced forms of technology-rich models. The model of urban economies relies on NEG principles but extends them to provide numerical analysis of location choices among multiple agglomerations and within urban areas, in line with both empirical evidence and microeconomic theory. These trends provide a spatial disaggregation of macroeconomic trends by representing explicitly agglomeration and land-use patterns as crucial determinants of mobility needs, economic activities and related negative externalities. , able to disaggregate spatially the economic activity into a set of urban agglomerations

The dialogue between these two models enables capturing both the driving effect of macroeconomic trends on urban dynamics and, conversely, the consequences of urban/regional location choices on mobility needs, investments and production possibilities affecting macroeconomic trajectories and carbon emissions. We use this integrated description of global macroeconomic trajectories and location decisions in multiple agglomerations to reassess the cost of climate policies when considering not only their global dimensions captured by carbon and energy prices, but also their local determinants associated to the spatial organization in urban areas. Among the latter, we focus more specifically on the interplay between constrained mobility needs corresponding to daily commuting distances, investment constraints due to housing and transport infrastructure deployment and land prices capturing the competition for different locations within agglomerations.

We analyze the effects of macroeconomic trends, oil price trajectories and technical change on the long-term dynamics of urban systems. We demonstrate in particular that the rise of energy prices increases commuting costs in urban areas and hence fosters a urban densification process during the next decades, whereas the diffusion of energy efficiency decreases the commuting costs and favors a dispersion of urban settlements in the long term. When a climate policy is adopted, the carbon price follows a trajectory that can be distinguished in three phases. In the short-term, the carbon price increases rather sharply and reaches 100\$/tCO_2 around 2030, because of the necessity to give a strong early signal to trigger emission reductions despite inertias on the renewal of technical systems and imperfect foresight. In the medium-term (2030-2060), the carbon price tends to decline, since carbon prices above 50\$/tCO_2 are sufficient to reach most of mitigation potentials in industry, residential and power sectors, which form the core of emission reductions. In the long-term, the carbon price features a sharp increase in order to reach the remaining high-cost mitigation

potentials (especially in the transport sector). The higher cost of fossil fuels (and hence of private transport) triggers a densification process in urban areas, which in turn tends to increase the price of land in urban areas.

We finally test the implementation of explicit policies at the urban scale, in the form of investments devoted to improve the compatibility of urban systems to the climate policy. These urban policies prove to reduce the cost of climate policy by facilitating the decrease of transport-related carbon emissions, but have the indirect effect of forcing further densification with losses of housing welfare. The overall effect however remains positive and such local policy adopted at the urban scale ensures a 15% decrease of mitigation costs.