

A HYBRID MODEL ASSESSING THE MACROECONOMIC IMPACTS OF ENERGY TRANSITION IN THE FRENCH POWER SYSTEM

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Overview

This paper analyses different macroeconomic issues raised about by a low-carbon transition in the power system, with an application to the long-run official scenarios for the power system in France (namely, Ampère and Volt). We study and model different macroeconomic channels of transmission of the low carbon transition via a hybrid model. The hybrid model combines, with a two-way soft link, a dynamic general equilibrium model and the partial equilibrium modelling of the power generation mix. The results suggest the relative importance of the price effect on energy consumption, the significant role played by the investments in durable goods in the macroeconomic consequences of the low-carbon energy transition, and show the differences in behavior between Ricardian and non-Ricardian households. We compare the macroeconomic effects of a carbon tax with different assumptions about the fuel price. If recycled, the carbon tax may not significantly harm the economic welfare of households but weigh (slightly) on the firms in the long run. Despite the rise of the fuel tax base in the long run, public finances may benefit from the electricity transition thanks to the carbon tax and substitution possibilities.

Methods

In this context, we develop a hybrid model (named HyGEM) that combines a dynamic general equilibrium model and a partial equilibrium model for the power generation system developed in-house at the French transmission system operator (RTE). The evolution of the power system (wholesale electricity prices, annualized electricity system costs, public subsidies, and wholesale market revenues) is linked to the dynamic general equilibrium model via a two-way soft link. Energy enters the dynamic general equilibrium model via households' energy services as in Henriët, Maggiar et Schubert (2014) and as a factor of production as in Hassler, Krussell et Olovsson (2012). Energy services produced by households add durable goods as a channel of propagation of energy shocks in the economy as in Dhawan et Jeske (2008) and Henriët, Maggiar et Schubert (2014). We carefully apply an estimation of the elasticities of substitution à la Klump et de La Grandville (2000), as in Léon-Ledesma, McAdam et Willman (2010) and Klump, McAdam et Willman (2012), that are key to the dynamics of an economy augmented by an energy module (see Papageorgiou, Saam et Schulte [2017]) such as the inter-energy elasticity of substitution. The model studies the effects of different, alternatives scenarios of changes in the relative price of fossil energy and the substitution effects associated with them.

Results

Our results suggest, on French data, that the electricity consumption dynamics simulated with macroeconomic feedbacks differs significantly to those simulated without macroeconomic feedbacks. The price effect on agents' energy consumption decisions is significant. Low carbon transition in the power sector may enhance the economic welfare of households in the long run provided that substitution possibilities and carbon tax revenues redistribution are implemented. Durable and capital goods may be a significant transmission channel of energy price shocks. The depressive effect of energy price shocks on aggregate supply can be mitigated by substitution possibilities and aggregate demand. Despite an erosion of the taxable base of fuel products, the switch to all-electric may not result in a shortfall of public revenues thanks in part to the possibilities of substitution. The evolution of the carbon tax and energy efficiency policies set by the French authorities are not enough to meet carbon neutrality by 2050 in our model. In our model, a relatively more electrified economy and relatively more "green" electricity production mix, as is the case for the *Ampère* scenario, allow the economy to be more resilient to changes in energy prices and carbon taxation, but at the cost of relatively lower decarbonization of the economy. We also analyze the differences in behavior between Ricardian and non-Ricardian households.

Conclusions

The paper builds on a hybrid model that combines a dynamic general equilibrium model and an optimization problem for the power generation sector to study the aggregate effects of the official scenarios of the low-carbon transition in the power sector in the long run in France. The results show that with some public policies (public subsidies to the power generation sector, constraints on the electricity mix, carbon taxation and policies promoting energy efficiency

efforts), the decarbonization of the economy and growth can be driven mainly by technical progress and substitution mechanisms. In our HyGEM model, the main transmission channel of the low-carbon transition is the demand for energy through the relative price of energy and the relative efficiency of energies. Therefore, considering the evolution of electricity prices along with to fuel prices, for an economy that is destined to electrify in the long term, seems to be key in our model. Moreover, the results show that, if carbon tax revenues are redistributed, household economic welfare is not harmed by the increase in carbon taxation in the long term. The effect of an increase in carbon taxation on firms is slightly negative. And, despite an erosion of the taxable base of energy products, the switch to all-electric do not result, all other things being equal, in a loss of revenue for administrations.

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