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ENDOGENOUS LEARNING AND COMPETITION AMONG ENERGY TECHNOLOGIES: AN ASSESSMENT OF CLIMATE STABILIZATION COSTS WITH THE MERGE-ETL MODEL

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Overview

This paper introduces results from the MERGE-ETL model (Kypreos and Bahn, 2003) that is currently being further developed for the EU-funded ADAM (ADAptation and Mitigation Strategies for Europe) project. MERGE-ETL is used to evaluate post-Kyoto and long term energy and climate policies, consistent with the overall target of below 2°C temperature rise above post-industrial level. Learning-by-doing and learning-by-searching for new and advanced energy technologies are introduced so as to assess the impacts of dedicated energy investments on the costs of achieving the climate stabilization target set at 450 ppm.

Methods

MERGE-ETL is a global, multi-regional integrated assessment model, including a disaggregation of the energy system in electric and non-electric sectors, a macro-economic production function and a simplified climate model. The value added of MERGE-ETL consists in the capability of examining the role of technological change in the global energy system, in the context of multi-gas climate-change mitigation strategies. The model allows for the assessment of the impact of alternative policy instruments aimed at stimulating technological change towards a low-carbon global energy system.

This MERGE-ETL builds upon endogenous levelized costs of energy production. The cost of the various energy technologies are broken down into the following components: fuel costs, provided from the primary resource extraction sector, operation and maintenance costs, and investment costs that incur some reduction as a result of endogenous learning (Barreto and Kypreos, 2004, Kypreos, 2005a,b). For this matter, we apply two-factor learning curves for the investment costs of each learning technologies. The investment cost reduction factors, per unit of energy produced by a given technology, is thus a decreasing function of the cumulative production, measuring experience, and of some knowledge stock, accounting for some dedicated R&D expenses. For each of those learning technologies, a barrier or floor cost is introduced so as to represent a maximum possible reduction in investment cost.

Results

Learning by doing and learning by searching are complementary activities that both drive the costs of speculative technologies down. The stringent stabilization target stimulates the penetration of advanced fossil technologies with carbon capture and sequestration, whereas the competitiveness of carbon-free energy sources decreases due to lack of accumulated experience.

The disabling of learning for each of the main climate mitigation possibilities increases the cost of carbon but enhances the penetration of the remaining learning technologies. However, binding capacity constraints prevent high expansion rates, at least in the mid term, so that picking winners are not insofar exhibited.
The role of uncertainty in the learning patterns is finally emphasized through sensitivity analysis.

Conclusions

Stringent climate policy reveals to be achievable when the full technological deployment is implemented. The cost of low climate stabilization is appreciably reduced when investments to new and advanced technologies are incurred. The more technological options are allowed, the lower the cost of climate stabilization and the lower the GDP losses. On another hand, the more competition between energy technologies, the less cumulative experience they can individually obtain, which in turn reduces the penetration potential of the most speculative ones.

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