EXPLORING THE MODELING IMPLICATIONS OF ALTERNATIVE LEARNING-BY-DOING SPECIFICATIONS

Marie Tamba, PhD Candidate, University of Strathclyde, Department of Economics,
Sir William Duncan building, 130 Rottenrow Street, G4 0GE Glasgow
Phone: +44 141 548 4340, email: marie.tamba@strath.ac.uk

Overview

Renewable energy technologies have become one of the priorities of energy policy makers in their objective to reduce carbon emissions. The penetration of these technologies in the electricity mix is highly dependent on the costs and risks associated with large-scale investment projects, and more importantly on the speed and path of costs reductions through potential technological improvements. To reflect this constraint, many recent climate and energy policy models, linking the energy system to the rest of the economy, have incorporated technological change as an endogenous feature in the form of learning-by-doing (LBD). Learning effects occur when the costs of a technology decrease as experience (using or producing this technology) increases (Wright, 1936). This phenomenon has been estimated and found significant for many energy technologies (IEA, 2000, Kahouli-Brahmi, 2008). It has, however, been implemented in various ways in the modeling literature.

Methods

This paper reviews the modeling literature incorporating LBD in the energy sector and points out major variations in the specification of LBD effects, mainly reflecting differences in modeling approaches (bottom-up or top-down). After recognizing the origins of those differences in the theoretical and empirical literatures, the paper identifies several alternative specifications of LBD which reflect the most commonly used features in past models. These specifications differ both in terms of equations form and variable choices. To test these specifications, a Computable General Equilibrium for Scotland is modified to introduce endogenous technological change in the production function. This energy-disaggregated model encompasses nine generation sectors competing to feed-in electricity to the grid. This enables the simulation of a targeted support policy (here, subsidies) to the marine electricity generation sector. Several simulations are run using the alternative specifications of LBD applied to the targeted sector.

Results

The results of the simulations show large divergences in the long-run aggregated and sectoral impacts of the subsidies when changing the LBD specification in the marine sector. The overall GDP impact resulting from the implementation of a 10% production subsidy to the marine sector covers a wide range from 0.53 to 1.13% across the series of simulations. At sectoral level, efficiency gains in production for the marine sector can more than triple when changing the LBD equation form while sectoral output can more than double. These results also proved highly sensitive to changes in the variable embodying experience and changes in parameter values.

Conclusion

Although endogenous LBD has become a common feature of energy-economy models, an in-depth review of the literature shows that there exist several specifications to represent this one phenomenon of costs reductions. Testing these specifications in a CGE model for Scotland reveals large variability in the simulation results. This reflects the need for modelers to clearly state their assumptions when introducing LBD, and the necessity to conduct a thorough sensitivity analysis of the results. Policy-makers must recognize the usefulness of endogenous LBD models for the analysis of RE policy support, while acknowledging the sensitivity of the analysis to specification and parameter choices.

References

International Energy Agency, IEA (2000) Experience Curves for Energy Technology Policy, International Energy Agency: Paris.

Kahouli-Brahmi, S. (2008) Technological Learning in energy-environment-economy modeling: A survey, Energy Policy, vol. 36, pp.138-162

Wright, T. (1936) Factors Affecting the Cost of Airplanes, Journal of Aeronautical Sciences, vol. 3(4), pp. 122–128