Student Poster

Exploring the Modeling Implications of Alternative Learning-By-Doing Specifications

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Exploring the Modeling Implications of Alternative Learning-By-Doing Specifications
An Application to Renewable Energy in Scotland

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1. Introduction

Background
Scottish Government’s Ambitious Targets
• 80% GHG emission reductions by 2050
• 42% Interim target reduction by 2020
As means to an end: renewable energy sources must generate the equivalent of:
100% of Scotland’s gross annual electricity consumption by 2020

Rationale
2 major policy goals to reach these targets at the lowest cost
• Renewable Energy Technologies deployment support (Renewable Obligation Certificates)
• Innovation must play a role
To reduce the costs of renewables
Policy and technological change influence each other in complex ways

Objective
Observing these interactions in a model for Scotland
• Modeling technological change
• Modeling policy support to renewables
• Do it simultaneously
Modeling Learning-by-Doing and subsidies to marine energy in a CGE model

2. Learning-By-Doing In the Literature
• The process by which unit costs decrease with cumulative experience (Wright, 1936) $C = C_0(G)^{-\alpha}$
• Numerous but wide-ranging estimates of learning rates for energy technologies (Kahouli-Brahmi, 2008)
• Popular method to incorporate endogenous technological change in Energy Economy Environment Models
• Major differences in specifications arise from a literature review of estimation and EEE modeling articles
  • Difference in experience proxy (traditional learning curve or endogenous growth)
  • Difference in equation form (traditional learning curve or endogenous growth)
  • Differences in parameter values (constant, increasing or decreasing returns to knowledge)

These specifications are likely to produce very different results in the modeling exercise

3. Simulations in a CGE Model of Scotland
• Energy-disaggregated Computable General Equilibrium model for Scotland
• Production subsidy to the marine electricity generation sector
• Introducing endogenous Hicks-neutral technological change as improvements in Total Factor Productivity in the CES production function
• 8 simulations with the same shock on the marine electricity sector but each with a different learning-by-doing specification, identified in the literature

The objective is to compare the impact of each specification on the modeling results and adjustment behaviors

4. Results
• The production subsidy has a positive impact on the Scottish Economy (GDP, Export, Employment)
• The positive shock to marine energy displaces generation from traditional sources (Gas, hydropower), but other sectors benefit from the economic expansion (fossil-fuel extraction, wind)
• Introducing Learning-by-Doing strengthens the economic expansion through efficiency gains in marine electricity production
• The specification of LBD matters greatly for the results
  • The endogenous growth specification leads to larger efficiency gains than traditional LBD
  • Using cumulative output as a proxy for experience results in S-shaped marine output adjustments and slightly larger positive impact than using cumulative investments
  • Diminishing returns to knowledge in the endogenous growth specification generates results closer to the traditional learning curve, while positive returns destabilise the model.

5. Conclusion
• Endogenous technological change is a crucial feature of Energy-Economy-Environment models for policy analysis.
• Learning-by-Doing and policy support interact in a complex system. Learning-by-doing is dependent on technology deployment, which in turn depends on the costs of the technology.
• The choice of learning-by-doing specification affects modeling results. Modelers must choose the best available option for their model type, state their assumptions and provide a sensitivity analysis to these assumptions.
• Technological Change is a complex system and more research is needed to identify the roles of learning-by-doing and R&D activities in technological development at different phases of maturity

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References: