Accounting for changes in investment flows in a soft-linked hybrid model

Maurizio Gargiulo
E4SMA Srl, Turin, Italy.
Environmental Research Institute, University College Cork, Ireland

Kristoffer Steen Andersen
Ph.D student
DTU Management Engineering
TIMES-DK and IntERACT developers
Agenda

• What is IntERACT
• Modelling approach
• Model setup and Linking approach
• Cockpit
• Summary
What is IntERACT?

- Purpose-built hybrid model for identifying cost efficient policies to further the Danish transition to a low carbon emission economy by 2050

www.ens.dk/interact
**IntERACT**: Hybrid model capturing the Danish economy and energy system

- **Technology explicitness**
- **General equilibrium feedback**
- **Behavioral realism**

**Bottom-up approach**: TIMES-DK model

**Top-down approach**: CGE model

Note: Adapted from Jaccard (2009)
Model setup

TIMES-DK energy system model
- Technology explicit

IntERACT Model
- General Equilibrium
  - 20 sectors
  - Utility maximisation
  - Profit maximisation
- Behavioural realism
- General equilibrium feedback

Change in demand for energy services on a sector level

- Price of energy services
- Price of intermediates such as electricity and district heating
- Energy subsidies and taxes
Energy service as a crux for linking

- The assumption is that firms and households make economic decision based on the (relative) prices of energy services.
- TIMES-DK determines the price of energy services and fuel mix (technology decisions happens in TIMES-DK).

- This is implemented in the CGE using **price-wedge** and as **Leontief-shares**.
- Agents maximise profit and utility using the costs of the energy service (relative prices as usual).

* Elasticities haven been estimated in the spring of 2015, find more info at: [www.ens.dk/interact](http://www.ens.dk/interact)
Accounting investment flows

• This soft-linking approach transfer energy (service) prices and fuel uses from TIMES to the CGE-model.

• Using the properties of the standard zero profit condition in the CGE-model the change in investment flow (capital demand) is calculated residually based on the change in energy service price and the change in fuel input.

• This suggest one possible approach for taking investment flows from bottom-up models into account.

• This approach is implicitly based on the assumption that only capital input and fuels input changes between different TIMES-DK scenarios.

• However if other inputs (labour and materials) also changes significantly between the scenarios then the calculated change in investment flow (capital demand) may suffer from a bias of some order of magnitude.
Defining baseline and alternative scenarios

**Top-down assumptions:**
- Growth assumptions, elasticities, macro closure.

**IntERACT cockpit (MS Excel)**
- Defining baseline and alternative scenarios

**Bottom-up assumptions:**
- Energy service demand, fuel cost, Technology catalog

**CGE reference**
- Baseline scenario (2010-2050)

**CGE productivity indices**
- 2015-2050

**TIMES-DK**
- Baseline scenario 2010-2050

**CGE alternative**
- Alternative scenarios 2010-2050

**CGE alternative**
- Alternative scenario 2010-2050

**TIMES-DK**
- Alternative scenario 2010-2050

**CGE->TIMES**
- Adjusted demand projection (%ZZ-CGE_Linking%.dd)

**TIMES -> CGE**
- Electricity and district heat production and prices
- Fuel use supply sector (%TIMESbaseline%.gdx)

**TIMES -> CGE**
- Electricity and district heat prices, fuel mix, subsidies and taxes (%TIMESscenario%.gdx)

**Report (2010-2050)**
Model setup

Baseline scenario

- Common data (e.g. Economic projection from Danish Ministry of Finance)
- The CGE model is calibrated using
  - Economic projection from the Danish Ministry of Finance and Information, and
  - TIMES-DK stand alone optimisation to set up some prices and fuel mix.
- CGE productivity indices are calculated so that the CGE-model match the Energy system in the TIMES-DK baseline.

Alternative scenarios

- Models are soft-linked and solved in an interactive process (5 ys steps up to 2050)
- The main tests have been done for power sector only model (3-5 iterations to solve the combined models).
IntERACT: Cockpit
The model is run in its own MS Excel user-interface
Summary

- IntERACT model developed a generic and rather efficient methodology for linking a TIMES-model to CGE-model.

- This methodology offers a way of taking the macro economic impact of changes in investment flow from TIMES model into account.

- Currently the automated iterative linking is functioning for power sector; exchanging information related to prices, production and demand for electricity and district heat.

- Work is currently underway testing the iterative linking and expanding it to the other parts of the energy system.
Thank you for your attention

For more information, feedback or question please contact:

Kristoffer Steen Andersen
Ph.D student
DTU Management Engineering
+45 6060 3159
krisan@dtu.dk

Maurizio Gargiulo gargiulo.maurizio@gmail.com

E4SMA Srl, Turin, Italy.

Environmental Research Institute, University College Cork, Ireland