Hybrid modelling to assess the socio-economic consequences of a low carbon transition: insights from E3ME

A presentation to the WholeSEM conference

Philip Summerton, Cambridge Econometrics

Cambridge, Tuesday 7 July 2015

Overview

- Present a summary of the E3ME model
- Provide examples of model coupling
  - partial energy model soft-linking
  - energy system model soft-linking
  - hybrid modelling
- Consider issues that arise when linking models

What is E3ME?

- A macroeconometric simulation model of the global economy, disaggregated by sector (69) and country/region (59)
  - econometrically specified
  - time path (dynamics) is important
  - disequilibrium in markets can persist
- Detailed modelling of material flows, energy balances and emissions
  - two way interaction with economy
  - top down and bottom up methodologies included
  - physical units of energy and materials modelled
- For more details see www.e3me.com

e3me

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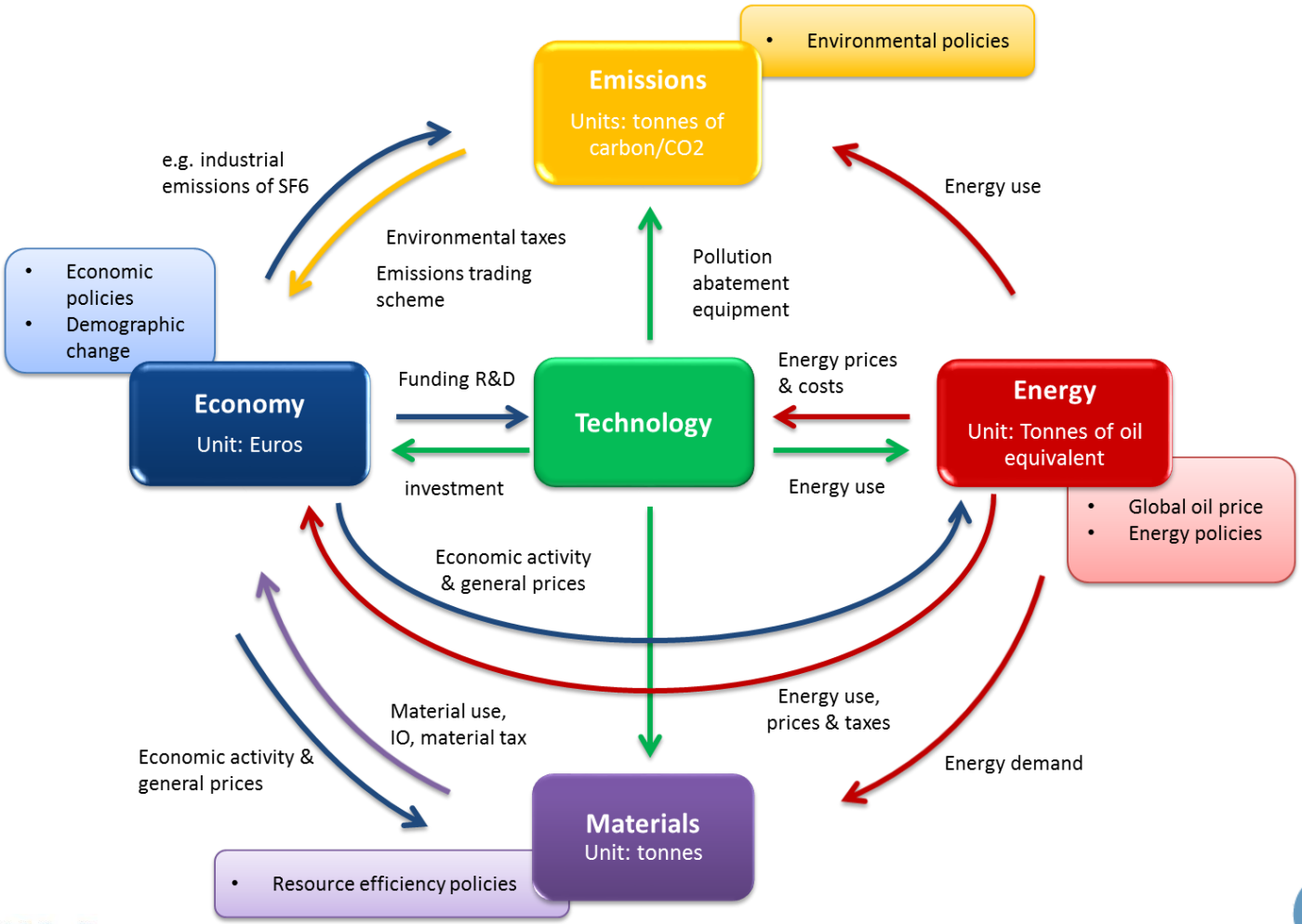
What is the purpose of E3ME?

- To provide policy relevant insight on issues such as:
  - sectoral growth, competitiveness and interconnectivity
  - labour market, unemployment, demographics, skills and wages
  - material/energy consumption, production, and trade
  - greenhouse gas emissions and local pollutants
- A few energy/climate example policy questions:
  - what is the economic impact of the EU ETS back-loading proposal?
  - what are the employment impacts associated with energy efficiency improvements in the domestic sector?

E3ME – is it a hybrid model?



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Modularity in E3ME

- E3ME is modular and modules can be replaced with more bespoke modelling approaches to particular questions:
  - at a partial level, eg integrating a housing stock model
  - at a system level, eg integrating an energy systems model
- E3ME can switch between solution methods within modules
  - using an integrated power sector model or exogenous projections of capacity and prices
  - or between a top-down model of road transport energy demand and a vehicle stock model

Example application 1

Project	Fuelling Europe's Future
Client	European Climate Foundation
Partners	Ricardo-AEA, Element Energy
Linkage	Soft-linked a vehicle stock model of light duty vehicles (SULTAN) with E3ME
Objective	Assess the macroeconomic impact of decarbonising Europe's light duty vehicle fleet
E3ME role	To provide a quantitative assessment of the socio-economic impacts of transformational change to the light duty vehicle fleet
Key findings	The research shows that a cost-effective transition to fuel efficient cars is possible and that, if this can be realised, it will improve the spending power of European consumers, with positive impacts for the wider economy, as modelled using E3ME. The transition from lower spending on fuel to increased spending on vehicles will also generate jobs across the European motor vehicle sector and its supply chain; while the reduction in spending on imported oil means that Europe's net trade position also improves.
Link	http://europeanclimate.org/economic-assessment-vehicles/
Other comments	Winner of the Low Carbon Vehicles Partnership Awards 2014 for "Outstanding Low Carbon Publication"

Example application 2

Project	Employment Effects of the EU 2050 Roadmap
Client	DG Energy, European Commission
Partners	Ernst&Young, Exergia, the Warwick Institute for Employment Research and National Technical University of Athens
Linkage	Soft-linked energy system model (PRIMES) with E3ME and compared to results of PRIMES coupled with GEM-E3
Objective	Assess the European employment and labour market impacts of the EU Energy Roadmap 2050 scenarios
E3ME role	To provide a quantitative assessment of the employment and labour market impacts at Member State level. The E3ME results are compared and contrasted to the GEM-E3 model results for the projected employment impacts
Key findings	E3ME predicts a more positive outcome for GDP and employment of meeting the EU 2050 Energy Roadmap than GEM-E3 due to differences in modelling philosophies.
Link	http://ec.europa.eu/energy/observatory/studies/doc/2013_report_employment_effects_roadmap_2050.pdf

Example application 3

Project	Economic Benefits of Decarbonising Global Electricity Sector
Partners	4CMR, University of Cambridge
Linkage	Hard-linked hybrid modelling - power generation
Objective	Assess the macroeconomic impact of decarbonising global electricity sector
E3ME role	To provide a quantitative assessment of the socio-economic impacts of decarbonising the global electricity sector using its integrated sub-module FTT for power generation
Key findings	The decarbonisation of the electricity sector globally can lead to improvements in economic performance (through higher investment and changes in economic structure).

Summary of findings

- A transition towards decarbonisation in Europe can have a small benefit the economy:
  - as a result of energy efficiency, structural changes to the energy system and changes in trade
  - the most optimal energy system solution is not necessarily the most beneficial, it depends on the economic structure of a region/country (trade, unemployment, etc)
  - time periods matter because of financing and the CAPEX/OPEX balance of the energy system
  - under assumptions of the world's economies that differ from the standard assumptions of (many) CGE models
    - eg full employment in the long term
  - excluding climate change impacts
  - excluding co-benefits for air pollution and health

Is soft-linking models reasonable?

- Provides ‘what if’ scenarios for economic modelling
  - “if a particular (optimal) energy system scenario is realised, what might be the consequences for the wider economy compared to another energy system future”
- Does not provide important two-way interlinkages
  - “the feedback from changes in the economy are not fed back to energy system – eg changes in demand”
  - needs careful interpretation
- Hard-linking detailed bottom-up models would be better…

Issues to consider when linking models

1. Conceptual
   a. compatibility of model types – is an optimising energy system model compatible with a macro-econometric (simulation) model?
   b. how to link overlapping models
   c. interpretation of results
2. Practical
   a. data format – units, time frequency, classification mapping
   b. harmonised assumptions
   c. iterations between models

Personal reflections

- Soft-linking models is a useful way to:
  - add detail and credibility to top-down models that have wider policy implications/insight
  - define ‘what-if’ scenarios of future energy systems to test in an economic model
- …but can be limited by not fully incorporating rebound effects between models
- Hybrid (hard-linking) modelling is more useful but requires consistency of approach
  - conceptual and practical

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