Options for accounting and modelling energy-economy interactions: a macroeconomic vs. sectoral basis

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Issues in considering accounting and modelling options

- Identification and treatment of activities where efficiency in energy use has improved/is projected to improve
- Identification and treatment of all sectors and markets that may be directly or indirectly impacted and/or through which impacts may be transmitted
- Ideally both multi-sectoral and economy-wide (national, regional?)
- Accounting – national input-output accounts, extended/tailored to consider energy uses and associated emissions (limited to target economy or incorporating key external interactions?)
- Modelling – need to consider both demand *and* supply, price *and* quantity determination, macroeconomic environment
- Main approach in literature has been CGE – incorporates input-output detail, prices and quantities modelled, solves for equilibrium in all markets (though market-clearing not required)

Modelling prices and supply, and country-specific economic conditions

- Increased efficiency in energy use (*in the form of technological progress*) causes reduction in implicit/effective price of energy, or price of energy service, in activity where efficiency improves
- Triggers series of effects – e.g. substitution (both targeted activity and any others it supplies inputs too), competitiveness (across economy), income effects (returns to labour and capital)
- Nature and magnitude of economic expansion will depend on range of economy-specific factors
  - Impact on prices (inputs and outputs)
  - Economic structure – factors such as importance (and energy intensity) of affected activity, supply chains (and associated multipliers) serving activities directly and indirectly affected, mix of domestic and export output destinations, openness to trade
  - Labour and capital supply conditions, behaviour and constraints
  - Macroeconomic conditions/ policy constraints, how additional revenues are used etc

Identifying sector/activity where energy efficiency improves

- Crucial to identify targeted sector and transmission mechanisms to wider economy
  - Unresolved issue – how efficiency improvement comes about and what type of costs may be involved
- Is the targeted sector/activity and the efficiency improvement important enough to have non-negligible impacts at economy-wide level?
  - Even if not, may still have important interactions between different sectors and markets (particularly in energy supply)
  - Distributional/compositional effects even if net impact small
- Spillover effects outside of target economy (and feedback?)
- *Key issue for nature of transmission – does efficiency increase on production or consumption side of the economy?*

Increased efficiency in industrial (productive) energy use

'Positive'

- GDP ↑
- Employment ↑ Unemployment↓
- Household income and expenditure ↑
- Government revenues↑
- Productivity ↑
- Prices ↓ competitiveness ↑
- Exports ↑
- Change in composition overall activity, but
- Gross investment/capacity ↑ (possibly crowding out if capacity constraints even if only short-run)

'Negative'

- 'Disinvestment' in type of energy supply affected
- Rebound in macro-level energy use and associated emissions (possibly dissipating over time)

Increased efficiency in household (end use/final consumption) energy use

'Positive'

- *Likely* GDP ↑
- With employment ↑ unemployment↓
- Household income and expenditure ↑
- Government revenues likely to ↑
- Gross investment/ capacity likely to ↑
- But change in composition of demand may involve lasting 'crowding out'

'Negative'

- Productivity unchanged
  - Though reduced wage demands may mimic through reduced (labour) input costs in production sectors?
- Prices? competitiveness?
- Exports?
- Domestic demand 'crowding out' export production and value-added in some sectors?
- Energy supply 'disinvestment'
- Rebound in macro-level energy use and associated emissions (possibly dissipating over time)

Rebound in macro-level energy use?

- Single measure of economy-wide rebound? Definition, composition?
- *Net* impact of upward *and* downward pressure on energy use in different parts of the economy
- Initial downward pressure in activity where efficiency increases
- Upward pressure on rebound from direct and derived demand responses as savings are realised and economy expands (with economy-specific *multiplier* effects impacting through sectoral supply chains)
- Impetus for rebound exacerbated if energy supply prices fall in response to reduced demand when efficiency increases
  - NEED TO MODEL LOCAL ENERGY SUPPLY MARKETS (GAS, ELECTRICITY, REFINED OIL (PRICE AT PUMPS)
  - WHEREVER LOCAL SUPPLY AND CONSTRAINTS ON CAPACITY, BUT LIKELY TO BE IMPORTANT AT GLOBAL LEVEL ALSO

Downward pressure on rebound (1)

- Turner (2009) – negative economy-wide rebound finding
- Source: negative multiplier effects in energy supply chain as industrial energy demand contracts with efficiency increase
- Recent input-output studies focussing on positive multiplier effects of re-spending effects as household energy efficiency increases
- Net re-spending effects likely to be negative? Reallocation of demand from energy outputs (and energy embodied in energy supply chain) to non-energy outputs (also with embodied energy)
- Issue of how economy-wide rebound is calculated (what is considered in identifying ‘potential energy savings’ from increased efficiency in energy use?)

Downward pressure on rebound (2)

- ‘Disinvestment’ effect in energy supply - downward pressure on rebound over time due to price response of energy suppliers if revenues, returns and investment in replacement/new capacity negatively affected by reduced demand as efficiency improves

GENERALLY

- NEED TO MODEL ENERGY SUPPLY BEHAVIOUR IN MICRO-MACRO MODEL SETTING (DIFFERENT TYPES OF ENERGY SUPPLY, STRUCTURE AND COMPETITIVENESS OF INDUSTRIES AND MARKETS)
- KEY FOR ‘DISINVESTMENT’ FINDING: RETURN ON CAPITAL
- PRIORITY: INVESTMENT, CAPITAL FORMATION AND PRICE SETTING BEHAVIOUR
- EXTERNAL ENERGY SUPPLY AND INTER-REGIONAL/NATIONAL SPILLOVER EFFECTS MORE GENERALLY (DEMAND AND SUPPLY EFFECTS, EXTERNAL ENERGY USE AND POLLUTION GENERATION)

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Selected papers (ESRC supported research)

- ‘”Rebound” effects from increased energy efficiency: a time to pause and reflect’, K. TURNER, forthcoming in ***The Energy Journal*** 2013
- ‘Rebound and disinvestment effects in refined oil consumption and supply resulting from an increase in energy efficiency in the Scottish commercial transport sector’ by S. ANSON and K. TURNER, ***Energy Policy***, 37, 3608-3620. 2009.
- ‘Negative rebound and disinvestment effects in response to an improvement in energy efficiency in the UK Economy, by K. TURNER, ***Energy Economics,*** 31, 648-666. 2009.
- ‘Do increases in energy efficiency improve environmental quality and sustainability?’ by N.D. HANLEY, P.G. MCGREGOR, J.K.SWALES and K. TURNER, ***Ecological Economics****,* 68, 692-7--09. 2009.
- ‘The impact of increased efficiency in the industrial use of energy: a computable general equilibrium analysis for the United Kingdom’, by G. ALLAN, N.D. HANLEY, P.G. MCGREGOR, J.K.SWALES and K. TURNER, ***Energy Economics,*** Vol. 29(4), pp. 779-798. 2007.

New research centre at Heriot-Watt University, Edinburgh, Scotland

- **C**entre for **E**nergy, **R**esource and **E**nvironmental **S**tudies, CERES (?)
- Core disciplinary input from the Department of Accounting, Economics and Finance
- Links to engineering, planning and physical sciences and interdisciplinary units (petroleum research etc) at Heriot-Watt
- And other Scottish universities (hopefully also RUK and ROW!) through the Scottish Institute for Research in Economics, particularly at the University of Strathclyde including economic and energy modelling team at the Fraser of Allander Institute
- Open to suggestions – please contact K.Turner@hw.ac.uk