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Local Energy Supply and Negative Rebound Effects

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The Rebound Effect

- Increase efficiency in the use of energy
- In the form of an increase in energy-augmenting technological progress
- Increases the effective supply of energy – energy services
- Reduces the effective or implicit price of energy
- Induces a demand response
  - Substitution effect in favour of energy in production or consumption as its relative price falls
  - Competitiveness effects where local output prices fall due to reduced cost per unit of output
  - Income effects throughout the economy as activity levels increase and/or purchasing power increases
- A rebound effect in energy consumption: $R = 1 + \frac{\Delta E}{\alpha \rho}$
- Partially or wholly (backfire) offsets energy savings from increased energy efficiency

Supply Response (1)

- Where energy is a produced commodity and prices are endogenous
  - E.g. local supply of energy – electricity generation and distribution, refined oil supply
- Initial decrease in demand for energy (efficiency effect) lowers the price of output in local energy supply sectors
- Further impetus for the rebound effect
- However, if demand (direct and derived) is not sufficiently elastic to prevent revenues from falling, return on capital will decrease and may lead to shedding of capital stock
- Disinvestment effect - dampens long run rebound
- Disinvestment – a necessary but not sufficient condition for rebound effects that are bigger in the short run than in the long run (Turner, 2009 – Wei, 2007; Saunders, 2009 – return on capital endogenous of exogenous)

Supply Response (2)

- However, even in absence of price effects, important supply-side response where there is local supply of energy
- Negative multiplier effects in energy supply sectors
- Initial decrease in demand for energy (efficiency effect) lowers demand for output in local energy supply sectors
- In reducing output, demand for inputs in energy supply sectors falls
- This triggers a negative multiplier effect
- Energy supply sectors tend to be relatively energy intensive so impacted by further rounds of multiplier
- If negative multiplier effects are sufficient to offset price induced rebound effects → negative rebound effects

Negative Rebound Effects

- Saunders (2008, p.20): “How can, say, a 1% increase in fuel efficiency result in a 2% decline in fuel use?”
- Notion of ‘Super conservation’ effects
- Empirical CGE analyses for Scotland and the UK (Turner, 2008, 2009) – observation of negative economy-wide rebound effects under some conditions (low general equilibrium price elasticity of demand for energy) – but with positive rebound in sectors targeted with energy efficiency improvement
- However, the computable general equilibrium (CGE) modelling frameworks used in Turner (2008, 2009) do not incorporate any of the production function specifications found by Saunders (2008) to produce super conservation effects
- Source: negative multiplier effects in local energy supply

Empirical framework – Scottish IO tables for 2004

- IO a limiting case of a general equilibrium modelling framework
  - Universal Leontief technology
  - Infinitely elastic supply
  - Quantity rather than price model (no response to changes in prices modelled)
- IO not suitable for modelling impacts of a supply shock such as increased energy efficiency
- However, can use to examine impacts of negative multiplier effects under conditions of zero general equilibirum price elasticity of demand for energy
- In 2004, 24% of output in the aggregate Scottish energy supply sector produced to meet export demand from other UK regions
- Assume all energy used in UK produced in Scottish energy supply sectors (ignore imports from ROW and RUK energy production) - model 5% increase in energy efficiency in RUK energy use as a 5% reduction in RUK demand for the output of Scottish energy supply sector

Multiplier matrix for the 2004 Scottish IO tables						
Type I Leontief inverse						
	1. Energy	2. Extraction, Quarrying, Construction and Water Supply	3. Agriculture & Fishing	4. Manufacturing	5. Retail, Distribution and Transport	6. Other services
1. Energy	1.429	0.021	0.040	0.057	0.026	0.013
2. Extraction, Quarrying, Construction and Water Supply	0.296	1.293	0.041	0.026	0.023	0.035
3. Agriculture & Fishing	0.002	0.004	1.123	0.027	0.008	0.002
4. Manufacturing	0.023	0.055	0.080	1.071	0.014	0.018
5. Retail, Distribution and Transport	0.040	0.061	0.092	0.077	1.156	0.063
6. Other services	0.101	0.177	0.149	0.089	0.175	1.279
Type I output multipliers (direct + indirect effects)	**1.892**	**1.611**	**1.526**	**1.348**	**1.400**	**1.410**

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Negative multiplier effect

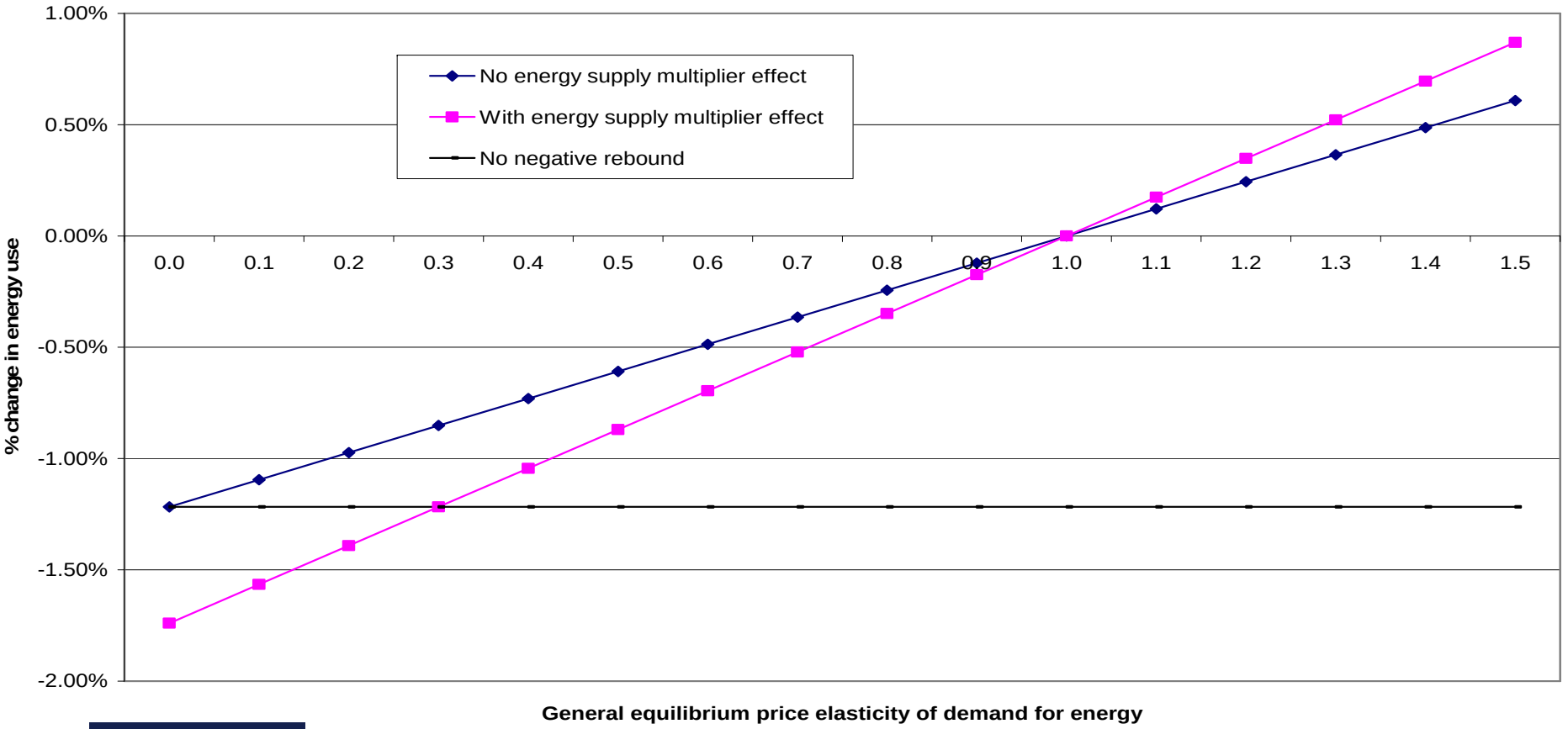
- Energy sector multiplier – £1.43 increase/reduction in demand for energy sector output for every £1 increase/decrease in final demand for output
- 43p is an indirect/multiplier effect – size due to energy intensity of energy production (30% of inputs to energy sector are own sector purchases)
- Impact of introducing a 5% decrease in RUK export demand for the output of the Scottish energy supply sector on energy use:

$$R = 1 + \frac{\Delta E}{\alpha\rho} = 1 + \frac{-1.74\%}{0.24 * 5\%}$$

$$\Rightarrow R = 1 + \frac{\Delta E_E + \Delta E_R + \Delta E_M}{\alpha\rho}$$

$$\Rightarrow R = 1 + \frac{-1.22\% + 0\% - 0.53\%}{1.22\%} = -43\%$$

Impact of negative multiplier effect in energy supply on total energy use and rebound effect



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Summary and Conclusions

- Negative multiplier effect introduces a wedge between the rebound effect and the general equilibrium price elasticity of demand for energy

- Key: cause of negative rebound (output demand driven multiplier effects) quite different to what drives positive rebound effects (response to changing price of energy services – implicit/effective and actual prices)

- Finding of negative rebound effects requires that
  1. Energy is a produced input
  2. There is local production/supply of energy

- Negative multiplier effects will always occur in response to an increase in energy efficiency where there is local energy production/supply and the general equilibrium price elasticity of demand for energy is inelastic (<1)
  - Net impact on economy-wide energy use depends on economic structure, sectors targeted with efficiency improvement and the general equilibrium price elasticity of demand for energy

- If there is no price responsiveness of (direct or derived) demand to falling effective and/or actual energy prices as a result of increased energy efficiency, negative rebound as a result of negative multiplier effects in local energy supply will be a guaranteed outcome

- On the other hand, where the general equilibrium price elasticity of demand for energy is elastic (>1), *positive* multiplier effects in energy supply will reinforce backfire effects

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Thank you for your attention – questions?

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