NOTE:
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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: \( R = 1 + \frac{\Delta E}{\alpha p} \)
- 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 $\rightarrow$ 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
• 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 equilibrium 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**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>1. Energy</td>
<td>1.429</td>
<td>0.021</td>
<td>0.040</td>
<td>0.057</td>
<td>0.026</td>
<td>0.013</td>
</tr>
<tr>
<td>2. Extraction, Quarrying, Construction and Water Supply</td>
<td>0.296</td>
<td>1.293</td>
<td>0.041</td>
<td>0.026</td>
<td>0.023</td>
<td>0.035</td>
</tr>
<tr>
<td>3. Agriculture &amp; Fishing</td>
<td>0.002</td>
<td>0.004</td>
<td>1.123</td>
<td>0.027</td>
<td>0.008</td>
<td>0.002</td>
</tr>
<tr>
<td>4. Manufacturing</td>
<td>0.023</td>
<td>0.055</td>
<td>0.080</td>
<td>1.071</td>
<td>0.014</td>
<td>0.018</td>
</tr>
<tr>
<td>5. Retail, Distribution and Transport</td>
<td>0.040</td>
<td>0.061</td>
<td>0.092</td>
<td>0.077</td>
<td>1.156</td>
<td>0.063</td>
</tr>
<tr>
<td>6. Other services</td>
<td>0.101</td>
<td>0.177</td>
<td>0.149</td>
<td>0.089</td>
<td>0.175</td>
<td>1.279</td>
</tr>
<tr>
<td><strong>Type I output multipliers (direct + indirect effects)</strong></td>
<td><strong>1.892</strong></td>
<td><strong>1.611</strong></td>
<td><strong>1.526</strong></td>
<td><strong>1.340</strong></td>
<td><strong>1.400</strong></td>
<td><strong>1.410</strong></td>
</tr>
</tbody>
</table>
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:

\[
R = 1 + \frac{\Delta E}{\alpha \rho} = 1 + \frac{-1.74\%}{0.24 \times 5\%}
\]

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

\[
\Rightarrow R = 1 + \frac{-1.22\% + 0\% - 0.53\%}{1.22\%} = -43\%
\]
Impact of negative multiplier effect in energy supply on total energy use and rebound effect

- No energy supply multiplier effect
- With energy supply multiplier effect
- No negative rebound

General equilibrium price elasticity of demand for energy
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
Thank you for your attention – questions?

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