Evaluating the macroeconomic impacts of energy efficiency

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Overview

- Introduction to macroeconomic impacts – how do they occur?
- Key macroeconomic indicators and modelling techniques used in estimation
- Overview of values from the literature
- Welfare effects
- Policy implications
Macroeconomic Impacts of EE

Microeconomic

Substitution effects

Income effects

Energy demand reduction effects

Macroeconomic impacts

Employment
Economic output
Energy prices
Trade balance

Investment effects

• Increased investment in energy efficiency
• Higher production in energy efficiency sectors
• Lower production in other sectors

Pricing effects
Growth effects

Source: IEA (2014) Capturing the Multiple Benefits of Energy Efficiency
## Key macroeconomic indicators of interest

<table>
<thead>
<tr>
<th>Impact</th>
<th>Indicator</th>
<th>Components</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic output</td>
<td>GDP</td>
<td>Consumer spending (C) Investment (I) Exports - imports (E) Government spending (G)</td>
<td>Total market value of all goods and services produced in a country Growth effect: sectoral reallocation, multiplier effect, induced innovation</td>
</tr>
<tr>
<td>Employment</td>
<td>No. of net new jobs</td>
<td>Net new jobs Sectoral shifts Wage rates Labour intensity</td>
<td>Number of net jobs created or lost, directly or indirectly through EE measures</td>
</tr>
<tr>
<td>Price effects</td>
<td>Energy unit price, CPI</td>
<td>Cost per unit energy Substitutability for energy, labour and other market conditions</td>
<td>Price effects through changed energy demand and economic activity</td>
</tr>
<tr>
<td>Trade balance</td>
<td>Exports, Imports</td>
<td>Investment choices Origin of goods and services</td>
<td>Change in trade flows through EE investments and reduced energy costs</td>
</tr>
</tbody>
</table>
Choosing an assessment approach to examine the macroeconomic impacts of EE policy

- Does the policy affect several sectors?
  - YES
    - Long timeframe?
      - YES
        - CGE model
      - NO
        - Input-output model
  - NO
    - Good data available?
      - YES
        - Econometric analysis, bottom up sectoral model, or partial top-down model
      - NO
        - Basic benefit-cost analysis
Some indicative values from modelling of macroeconomic EE impacts

<table>
<thead>
<tr>
<th>Category</th>
<th>Range</th>
<th>Median</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in GDP per unit investment (EUR/EUR)</td>
<td>0.91 - 3.73</td>
<td>1.81</td>
<td>Copenhagen Economics; EC, 2011; Lehr et al., 2012</td>
</tr>
<tr>
<td>Change in household income per unit investment (EUR/EUR)</td>
<td>-0.16 - 0.88</td>
<td>0.34</td>
<td>OECD, 2013; Lehr et al., 2012; EC, 2011</td>
</tr>
<tr>
<td>Jobs created per year per unit investment (jobs/million EUR)</td>
<td>0.0 - 17.07</td>
<td>11.64</td>
<td>Copenhagen Economics; EC, 2011; Lehr et al., 2012; Cambridge Econometrics, 2014</td>
</tr>
<tr>
<td>Jobs created per PED savings (Jobs per ktoe)</td>
<td>0.76 - 19.61</td>
<td>7.06</td>
<td>Copenhagen Economics; Lehr et al., 2012; Barker and Foxon, 2008</td>
</tr>
<tr>
<td>Industrial productivity (change in output)</td>
<td>0.1 - 0.4%</td>
<td></td>
<td>Cambridge Econometrics, 2014</td>
</tr>
</tbody>
</table>
Irish example - SEAI analysis of HES scheme

- Other costs: lost VAT and carbon tax due to the reduction in energy use of scheme participants €163.5 million
- Inflows to the Exchequer: the value of CO2 savings on the basis of avoided need to purchase carbon credits (37% of benefits) and eventual inflow of VAT (50% of benefits)
- Estimated NPV: €481 million over lifetime of technologies (including Energy, CO$_2$ and other pollutant savings) or -€0.028 €/kWh saved
- Employment effects: 60% of overall expenditure estimated on labour (without I/O tables)
- 2010: estimated expenditure more than €72 million, directly support 2000 full-time jobs (ave industrial wage); with indirect jobs, over 3000 jobs in 2010.

Energy repercussions of increase in economic activity

- Macroeconomic impacts appear to be welfare-enhancing
- However, GDP growth historically linked to energy consumption

Energy intensity

Rebound effects vs welfare

- Definition: A behavioural response to an improvement in energy efficiency that reduces or even eliminates the energy savings expected from the improvement. It is the difference between the real and predicted reductions in energy consumption.

\[
\text{Rebound effect (\%)} = \frac{\Delta E_{\text{pred.}} - \Delta E_{\text{real}}}{\Delta E_{\text{pred.}}} = 1 - \frac{\Delta E_{\text{real}}}{\Delta E_{\text{pred.}}}
\]

- Are rebound effects beneficial for social welfare?
  - Many investment and spending effects are welfare-enhancing and lead to economic growth.
  - Generally viewed negatively but analysis of welfare effects needed.
Macroeconomic effects and GHG emissions reductions

<table>
<thead>
<tr>
<th>Study</th>
<th>Energy savings</th>
<th>GDP growth (EUR billion)</th>
<th>Additional energy (Mtoe)</th>
<th>Rebound effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>GWS</td>
<td>6.20%</td>
<td>18</td>
<td>2.14</td>
<td>11.6%</td>
</tr>
<tr>
<td>E3ME</td>
<td>15.4%</td>
<td>30</td>
<td>3.60</td>
<td>1.3%</td>
</tr>
<tr>
<td>Cop. Econ.</td>
<td>5.40%</td>
<td>153</td>
<td>183.60</td>
<td>28.2%</td>
</tr>
</tbody>
</table>

Emissions Reductions (Gt CO₂)

- Nuclear 8% (8%)
- End-use fuel switching 12% (12%)
- CCS 14% (17%)
- Renewables 21% (23%)
- Power generation efficiency and fuel switching 3% (1%)
- End-use fuel and electricity efficiency 42% (39%)

Source: IEA (2014) Energy Technology Perspectives.
Policy Implications

- Macroeconomic impacts of EE are generally positive – increased economic activity, employment; price effects and trade balance: country-dependent
- Need more integration of macroeconomic impacts in EE programme evaluation
- Trade-off between welfare gains and “lost” energy savings and GHG emissions likely
- EE measures should be evaluated on a wider basis than energy and GHG emissions savings alone; more analysis of welfare effects of EE and macro rebound effects needed – optimisation, indifference curves…?
- When net positive welfare effects => don’t mitigate rebound
  BUT
- GHG mitigation strategy needs to account for “lost” emissions
Thank-you

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Main references

- Turner, K. (2013) Rebound effects from increased energy efficiency: A time to pause and reflect”, *The Energy Journal*, 34:4, IAEE.