Carbon Leakage Effects of Climate Policies

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Overview (1)

- ETP: value added of a global model
- Carbon leakage
- The EMP project models
- Results: leakage and trade effects
- Conclusions
ETP prospects

- Global model with regional detail
- Less detail than national MARKAL models (end use, regional detail)
- Value added: Global technology potential, supply security, CO2 permit trade, global learning, global commodity trade/leakage effects (energy, materials, food)

1st bottom-up model within IEA
Linked to established IEA products (WEO)

Carbon Leakage

- Increase of emissions outside the policy area
- Two channels:
  - Resource (energy) price
  - Production location choice (Industry/Agriculture)
- Top-down econometric estimates: 20-30% leakage; energy channel dominates
The EMP project

- Energy and Materials Policy design
- National Institute for Environmental Studies NIES, Japan
- November 2000 - February 2002

http://www.resourcemodels.org

The EMP project models I

- November 2000-February 2002
- Philosophy: impossible to build one single comprehensive global model (MATTER experience)
- Instead global regionalised sector/commodity models
- Combination physical flows and economics is essential
The EMP project models II

- GAMS/CPLEX LP/MIP models
- Energy & Material commodity flows “from cradle to grave“
- Global regionalised with commodity trade
- Each problem requires unique approach: modular GAMS code design

The EMP project models III

- Allow input calculations (Excel)
- Input + code accessible to 3rd parties (Excel/Internet)
- Data organization different
- Minimize data (technology once)
- Choice early starting year/late end year to allow validation, avoid resid’s and salvaging
- Flexible reporting (Excel)
The EMP models IV

- More economics
  - Monopolies/oligopolies
  - Trade tariffs
  - Interregional transportation cost
  - Region-specific investment cost, fixom
  - Demand elasticities
  - Interregional CO2 permit & commodity trade
- Higher rigidity: all processes upper bounds, no lower bounds

The EMP project models V

- FREAK: Petrochemicals (Gielen & Yagita, 2001)
- STEAP: Iron and Steel (Gielen & Moriguchi 2002)
- BEAP: Agriculture and forestry products + whole global energy system (Gielen, Fujino, Hashimoto, & Moriguchi, 2002)
Model characteristics

<table>
<thead>
<tr>
<th></th>
<th>BEAP</th>
<th>FREAK</th>
<th>STEAP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope</strong></td>
<td>Global (12 regions)</td>
<td>Global (7 regions)</td>
<td>Global (11 regions)</td>
</tr>
<tr>
<td><strong>Time span</strong></td>
<td>1965-2040 (5 yrp)</td>
<td>1995-2035 (10 yrp)</td>
<td>1965-2040 (5 yrp)</td>
</tr>
<tr>
<td><strong>Number of processes</strong></td>
<td>176</td>
<td>100</td>
<td>74</td>
</tr>
<tr>
<td><strong>Number of commodities</strong></td>
<td>83</td>
<td>50</td>
<td>33</td>
</tr>
<tr>
<td><strong>Matrix size</strong></td>
<td>500,000*600,000</td>
<td>40,000*55,000</td>
<td>200,000*200,000</td>
</tr>
<tr>
<td><strong>Permit trade</strong></td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Objective function</strong></td>
<td>Consumer/producer surplus</td>
<td>System cost</td>
<td>Consumer/producer surplus</td>
</tr>
</tbody>
</table>

Results

- **BC = Base Case (no new policy)**
- **E = Europe**
- **GLOB = Global**
- **J = Japan**
- **N = North America**

- Various penalty levels, code indicates penalty (EUR/t CO2eq + policy region)
Results II: FREAK (Petrochemicals 2020)

Results III: STEAP (I&S) CO2 Leakage
Results IV: Impact import tariffs on leakage [%]
Tax 25 EUR/t CO2

<table>
<thead>
<tr>
<th>Tariff</th>
<th>No tariff</th>
<th>25 EUR/t steel</th>
<th>50 EUR/t steel</th>
<th>100 EUR/t steel</th>
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<tbody>
<tr>
<td>2015</td>
<td>47</td>
<td>10</td>
<td>-13</td>
<td>-17</td>
</tr>
<tr>
<td>2020</td>
<td>55</td>
<td>7</td>
<td>-11</td>
<td>0</td>
</tr>
<tr>
<td>2025</td>
<td>52</td>
<td>-48</td>
<td>-113</td>
<td>-110</td>
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Results V: BEAP

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<tr>
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<tbody>
<tr>
<td>BC</td>
<td>0</td>
<td>0</td>
<td>48.3</td>
</tr>
<tr>
<td>12JENO</td>
<td>21</td>
<td>1.9</td>
<td>46.4</td>
</tr>
<tr>
<td>25JENO</td>
<td>19</td>
<td>4.3</td>
<td>43.2</td>
</tr>
<tr>
<td>50JENO</td>
<td>8</td>
<td>5.8</td>
<td>38.8</td>
</tr>
<tr>
<td>100JENO</td>
<td>9</td>
<td>6.2</td>
<td>32.7</td>
</tr>
</tbody>
</table>
Results VI: impact model time horizon on afforestation

Results VII: impact model time horizon on bioenergy
Conclusions

- 20% leakage in continued Kyoto: same result as econometric models
- 9% leakage in case of LULUCF trade
- Sector impacts significant
  - Iron and Steel 50-75%
  - Petrochemicals 40-50%
  - Food commodities <20%
- Sensitive for trade barriers

Suggestions for ETP

- Not one model, but a modelling toolbox
- Add inter-regional physical material/agricultural product flows?
- Speed up current ETP model?
- Time horizon 2100 + starting year?
- More detail industry
- Add land use module
- MIP investment decisions
Suggestions for ETSAP

- Expand to more specific global regionalized models - sub-tasks?
- Involve trade modellers (eg GTAP)
- How to distribute burdens and credits among partners?