DEVELOPING AND MODELING POLICIES TO REDUCE REBOUND EFFECTS

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1. Research question

- ReCap project (https://www.macro-rebounds.org/english/)
  - Reconsidering the Role of Energy and Resource Productivity for Economic Growth, and Developing Policy Options for Capping Macro-Level Rebound Effects
  - Three year project funded by BMBF as part of FONA
  - Partners: IÖW Berlin (lead), University of Göttingen

- Despite various policy measures (such as National Energy Efficiency Action Plans) energy consumption is declining less than expected
  - Have rebound effects been neglected?
  - What are magnitude and drivers of rebounds?
  - How to model and address them?
Rebound definition in ReCap

- Only part of rebound effects considered in PANTA RHEI

**Macroeconomic rebound effects**
- International: international trade and relocation, international energy markets
- National: general market price of energy, macroeconomic multiplier

**Meso-economic rebound effects**
- Single energy market: energy price in one energy market
- Intermediate goods and services: output, lower prices and higher sales
- Final goods and services: lower prices and higher sales, income, substitution

**Microeconomic rebound effects**
- Firms: direct, output, substitution, indirect
- Households: direct, output, substitution, indirect
Context of analysis

- Ambitious target to reduce energy use by 30% against 2008 until 2030
- Period under consideration: 2020-2030
- Analysis of rebound effects in German industry
- Growing number of research papers on “rebound”
- Various studies exist for other countries that use macroeconomic models to calculate rebounds
- Use of the PANTA RHEI model, which is also applied for socioeconomic impact assessment in the German NECP process
2. Model structure

► Mapping of effects in the macroeconometric model PANTA RHEI
► Dynamic input-output model, myopic expectations
► does not follow any optimization algorithm
► Focus is on meso and macro level
► More information in Lutz et al. 2021, accepted in Economic Systems Research
Model adjustment

- Final energy consumption ($E_i$) of every industry is modeled as dependent of respective production ($Y_i$), relative prices ($\frac{PE_i}{PY_i}$) and trends

\[
E_i = \hat{\beta}_{0,i} + \hat{\beta}_{1,i} \ast (1 - \delta_i) \ast Y_i + \hat{\beta}_{2,i} \ast \frac{PE_i}{PY_i}
\]

with $\delta_i$: Efficiency improvement in industry $i$

<table>
<thead>
<tr>
<th>Industry</th>
<th>Production elasticity</th>
<th>Price elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quarrying, other mining</td>
<td>0.57</td>
<td>-0.04</td>
</tr>
<tr>
<td>Food and tobacco</td>
<td>0.25</td>
<td>-0.06</td>
</tr>
<tr>
<td>Paper</td>
<td>0.51</td>
<td>-0.07</td>
</tr>
<tr>
<td>Basic chemicals</td>
<td>0.59</td>
<td>-</td>
</tr>
<tr>
<td>Other chemical industry</td>
<td>0.23</td>
<td>-</td>
</tr>
<tr>
<td>Rubber and plastic products</td>
<td>0.31</td>
<td>-0.07</td>
</tr>
<tr>
<td>Glass and ceramics</td>
<td>0.37</td>
<td>-0.25</td>
</tr>
<tr>
<td>Mineral processing</td>
<td>0.87</td>
<td>-0.36</td>
</tr>
<tr>
<td>Manufacture of basic metals</td>
<td>0.33</td>
<td>-0.35</td>
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<tr>
<td>Non-ferrous metals, foundries</td>
<td>0.50</td>
<td>-0.38</td>
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<tr>
<td>Metal processing</td>
<td>0.14</td>
<td>-0.09</td>
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<tr>
<td>Manufacture of machinery</td>
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<td>-0.21</td>
</tr>
<tr>
<td>Manufacture of transp. equipment</td>
<td>0.31</td>
<td>-0.36</td>
</tr>
<tr>
<td>Other segments</td>
<td>0.65</td>
<td>-0.14</td>
</tr>
</tbody>
</table>

- Estimates based on the AFiD panel by the project partner Uni Göttingen (Panel of Cost Structure Survey for years 2003-2014, all German manuf. Companies with more than 20 employees)
Rebound effects due to efficiency increase

- Efficiency increase takes place in the form of relative savings in final energy consumption in industry
- Determination of rebounds: potential versus actually realized reduction in energy consumption as a percentage.

\[
\theta_i = 1 - \left( \frac{E_{i}^{\text{actual}}}{E_{i}^{\text{reference}}} - 1 \right) \left( \frac{E_{i}^{\text{targeted}}}{E_{i}^{\text{reference}}} - 1 \right)
\]

- Targeted (potential) energy consumption must be known for quantification: possible for efficiency improvement, difficult regarding policy measures
3. Rebound effects in industry in 2021/2030

- High rebounds in minerals, metals, transport equipment
- Economy-wide rebound larger than in industry
- Level of rebound effects depends, among other things, on price elasticities of energy demand
Macroeconomic rebound

Final energy consumption until 2030

Targeted reduction in industry: 7.4%; realized: 6.5%
4. Scenarios: Accompanying policy measures

1) **Reinvestment requirement**
   - 50% of the savings are used by companies for further efficiency measures

2) **CO₂ pricing**
   - Pricing of up to 180€/t CO₂eq in 2030.

3) **Reimbursements**
   - Reduction of the EEG levy

4) **Tax reform**
   - Higher taxation of the energy factor (50% higher tax rates), lower taxation of the labor factor

5) **Reduction of working hours**
   - Reduction by 10% with half wage compensation
Combined effects on energy use in 2030

- Efficiency programme in industry and carbon pricing (in non-ETS) contribute most to energy savings
- Reduction of EEG levy will increase use of electricity
Effects on other SD indicators in 2030

- Reinvestment goes in the wanted direction for all indicators
- Carbon pricing (without recycling) has negative economic effects and reduces CO$_2$ emissions
- Reduction of EEG levy: Trade-off between emission increase and positive economic effects
## Effects on energy consumption

### Reinvestment

- **Reduction of energy use in industry**
- **No (big) macroeconomic effects**

### Tax reform

- **Small mixed effects on energy use in industry**
- **Larger reduction in economy-wide energy use**
- **Small negative effect on GDP**
Effects on energy consumption

Carbon pricing

- Only effective in non-ETS sector/industries
- Larger reduction in total energy use
- Negative GDP effect (without revenue recycling)

Reduction of EEG levy

- Lower electricity prices in industries without exemptions
- Increase in energy (electricity use)
- Positive GDP effect
5. Conclusions and outlook

► No one-fits-all measure: **Policy-mix** needed
  ➞ Price instruments are important

► Modelling should also account for rebounds
  ➞ Include potential rebounds in modelling of policy instruments
  ➞ Consider global level

► Other impacts/SDGs also matter: employment, prices, GDP
  ➞ How are they related to energy consumption/energy prices?

► Policy
  ➞ Acceptance is important
  ➞ Higher efficiency targets to consider rebounds
  ➞ Systemic view: Transformation necessary because of technological limits of efficiency gains
  ➞ **Renewables and efficiency** needed for GHG neutrality
Thank you for your attention.

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References:

How to model rebounds in PANTA RHEI?