Empirical Assessment of the Effectiveness of Green Policies

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Motivation

- Debate about most effective policy measure to reduce emission of GHG

**Definition:** Effectiveness of Policy Measure = elasticity of energy demand

- Focus on demand side policies
- Estimation of price elasticities is well established but what about tax elasticities?
- International comparison of the effectiveness of green policies
- Differentiation between price and tax effects
1. Motivation
2. Literature
3. Data
4. Empirical strategy
5. Results
6. Conclusion & Outlook
• Hughes, Knittel and Sperling (2008), “Evidence of a shift in the short
run price elasticity of gasoline demand”, The Energy Journal


• Li, Linn and Muehlegger (2012), “Gasoline Taxes and Consumer

• Cooper (2003), “Price elasticity of demand for crude oil: estimates for
23 countries”, OPEC Review.
• **Panel data:** - 1965-2010 (yearly)
  - OECD countries + significant emerging countries

• **Taxes:** - OECD Revenue Statistics
  → calculation of implicit unit tax rates (direct/indirect)

**Definition:**
- Direct taxes = taxes levied on energy product
- Indirect taxes = taxes levied on complementary goods

- IEA Energy Prices and Taxes Statistics
  → differentiation possible according to sectors
  (household and industry), but: only direct taxes

• **Goal:** - include data for subsidies and other regulatory measures
  → creation of a harmonized dataset for green policies
Dieler

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source: OECD, IEA, own calculations
Empirical Strategy

- **Demand function**: \( q_t = e^{\alpha} \cdot p_t^\beta \cdot \gamma_t^\gamma \)
  
  \( q_t \): oil demand per capita in year \( t \)
  
  \( e^{\alpha} \): constant
  
  \( p_t \): price in year \( t \)
  
  \( \gamma_t \): GDP per capita in year \( t \)

- **Estimation equation (panel)**:

  \[
  \ln \left( \frac{q_{i,t}}{q_{i,t-1}} \right) = \alpha + \beta \cdot \ln \left( \frac{p_{i,t}}{p_{i,t-1}} \right) + \gamma \cdot \ln \left( \frac{\gamma_{i,t}}{\gamma_{i,t-1}} \right) + \rho_t + \varepsilon_{i,t}
  \]

  \[
  q_{i,t} = \alpha + \beta \cdot p_{i,t} + \gamma \cdot \gamma_{i,t} + \rho_t + \varepsilon_{i,t}
  \]

  \( \rho_t \): time fixed effects

  \( \varepsilon_{i,t} \): country-specific error terms

  \( \Rightarrow \beta \) is price elasticity of demand
Problem of price endogeneity!

- **IV-approach:** changes in taxes as instrument for price (Davis and Kilian 2011)
  - estimation of tax elasticities

- **Structured VAR approach:** simultaneous estimation of price and tax elasticities
### Panel OLS Estimates

<table>
<thead>
<tr>
<th></th>
<th>Panel (38 countries)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil demand</td>
<td></td>
</tr>
<tr>
<td>Oilprice</td>
<td>-0.093</td>
</tr>
<tr>
<td></td>
<td>(0.021)***</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>0.157</td>
</tr>
<tr>
<td></td>
<td>(0.044)***</td>
</tr>
<tr>
<td>Const.</td>
<td>-0.006</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.03</td>
</tr>
<tr>
<td>$N$</td>
<td>785</td>
</tr>
</tbody>
</table>

* $p<0.1$; ** $p<0.05$; *** $p<0.01$
## IV estimates of diesel demand

<table>
<thead>
<tr>
<th>Variables</th>
<th>Austria households</th>
<th>Austria industry</th>
<th>Chile households (1)</th>
<th>Germany households</th>
<th>Germany industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel tax</td>
<td>-0.286 (0.125)**</td>
<td>-0.408 (0.245)*</td>
<td>-0.290 (0.204)</td>
<td>-0.175 (0.061)**</td>
<td>-0.286 (0.183)</td>
</tr>
<tr>
<td>Const.</td>
<td>0.027 (0.010)*****</td>
<td>0.026 (0.010)**</td>
<td>0.042 (0.024)*</td>
<td>0.013 (0.005)*****</td>
<td>0.015 (0.007)****</td>
</tr>
<tr>
<td>N</td>
<td>31</td>
<td>31</td>
<td>9</td>
<td>31</td>
<td>31</td>
</tr>
</tbody>
</table>

* p<0.1; ** p<0.05; *** p<0.01
(1) no observations for Chile industry
Conclusion & Outlook

Conclusion:

• Taxes on oil products do reduce consumption
• Large differences between countries

Outlook

• Further development of the harmonized green policy database
• Integration of findings into an IAM
• Extension of the theoretical foundation
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Phone: +49/89/9224 1346
## Results

### IV estimates of diesel demand

<table>
<thead>
<tr>
<th>Variables</th>
<th>Ireland households</th>
<th>Ireland industry</th>
<th>Netherlands households</th>
<th>Netherlands industry</th>
<th>Norway households</th>
<th>Norway industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel tax</td>
<td>-0.223 (0.122)*</td>
<td>-0.328 (0.197)*</td>
<td>0.065 (0.049)</td>
<td>0.289 (0.283)</td>
<td>-0.165 (0.093)*</td>
<td>0.091 (0.140)</td>
</tr>
<tr>
<td>Const.</td>
<td>0.045 (0.013)***</td>
<td>0.049 (0.016)***</td>
<td>0.013 (0.005)**</td>
<td>0.004 (0.014)</td>
<td>0.010 (0.008)</td>
<td>0.014 (0.012)</td>
</tr>
<tr>
<td>$N$</td>
<td>31</td>
<td>31</td>
<td>31</td>
<td>31</td>
<td>13</td>
<td>31</td>
</tr>
</tbody>
</table>

* $p<0.1$; ** $p<0.05$; *** $p<0.01$
### IV estimates of diesel demand

<table>
<thead>
<tr>
<th>Variables</th>
<th>Poland households</th>
<th>Poland industry</th>
<th>Sweden households</th>
<th>Sweden industry</th>
<th>Switzerland households</th>
<th>Switzerland industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel tax</td>
<td>-0.029 (0.202)</td>
<td>-0.085 (0.037)**</td>
<td>-0.098 (0.035)**</td>
<td>-0.056 (0.050)</td>
<td>-0.285 (0.154)*</td>
<td>0.416 (0.389)</td>
</tr>
<tr>
<td>Const.</td>
<td>0.053 (0.026)**</td>
<td>0.059 (0.017)**</td>
<td>0.017 (0.005)**</td>
<td>0.013 (0.006)**</td>
<td>0.022 (0.007)**</td>
<td>0.004 (0.011)</td>
</tr>
<tr>
<td>$N$</td>
<td>16</td>
<td>23</td>
<td>31</td>
<td>31</td>
<td>30</td>
<td>15</td>
</tr>
</tbody>
</table>

*$p<0.1$; **$p<0.05$; ***$p<0.01$