Relation between wind and electricity prices in a deregulated market: the case of Ireland

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Interaction between greater renewable generation and electricity prices

- Growing importance of renewables
- How does this affect consumers in the short run? (effect on prices)
- Look at actual (historic) results
Why Ireland?

- Main characteristics of Irish Single Electricity Market:
  - Compulsory market with capacity payments
    - System-wide data, publicly available on (half)hourly basis
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Shadow Price and fuels

Figure: Relation between shadow price and generation fuels, €/MWh
## Summary Statistics 2009-2011

<table>
<thead>
<tr>
<th>Variable</th>
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<td>ShadowPrice ($€/MWh)</td>
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<td>20.87961</td>
<td>0</td>
<td>463.38</td>
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Estimate simultaneous system of equations

- residuals correlated across groups (hours of day)
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System of equations with $i = 1, \ldots, n, \ldots, 24$ (number of hours)
Shadow Price: model

System of equations with $i = 1,...n,...24$ (number of hours)

$$P_{i,d} = \alpha_i + \sum_h \beta^h_i L^h_{i,d} + \gamma_i W_{i,d} + \sum_j \zeta^j_i F^j_{i,d-1} + \mu_i CO_{d-1} + \theta_i mar_{i,d} + \sum \kappa^s_i D^s_i + \epsilon_{i,d}$$  \hspace{1cm} (1)

where

$P$ = shadow price
$L$ = demand
$W$ = wind
$F$ = fuel prices
$CO$ = CO2 permit prices
$mar$ = generation margin
$D$ = dummy variables (months, day of week)
Shadow Price: Results (select)

<table>
<thead>
<tr>
<th>Hour</th>
<th>Loads</th>
<th>Wind</th>
<th>Gas_{d-1}</th>
<th>GenMargin</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0.004***</td>
<td>0</td>
<td>0.616***</td>
<td>-0.003***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.037)</td>
<td>(0)</td>
</tr>
<tr>
<td>4</td>
<td>0.003**</td>
<td>-0.003***</td>
<td>0.578***</td>
<td>-0.003***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.03)</td>
<td>(0)</td>
</tr>
<tr>
<td>5</td>
<td>0.001</td>
<td>-0.006***</td>
<td>0.534***</td>
<td>-0.004***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.037)</td>
<td>(0)</td>
</tr>
<tr>
<td>16</td>
<td>0.004***</td>
<td>-0.002*</td>
<td>0.414***</td>
<td>-0.005***</td>
</tr>
<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.069)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>17</td>
<td>0.004***</td>
<td>-0.002***</td>
<td>0.444***</td>
<td>-0.005***</td>
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<tr>
<td></td>
<td>(0.001)</td>
<td>(0.001)</td>
<td>(0.069)</td>
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<tr>
<td>18</td>
<td>0.006***</td>
<td>-0.003*</td>
<td>0.516***</td>
<td>-0.004***</td>
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<tr>
<td></td>
<td>(0.002)</td>
<td>(0.001)</td>
<td>(0.089)</td>
<td>(0.001)</td>
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<tr>
<td>19</td>
<td>0.010*</td>
<td>-0.008**</td>
<td>0.843***</td>
<td>-0.010***</td>
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<td></td>
<td>(0.005)</td>
<td>(0.003)</td>
<td>(0.202)</td>
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<tr>
<td>20</td>
<td>0.012**</td>
<td>-0.003</td>
<td>0.580***</td>
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Wind coefficient, averaged across 24 hours, weighted by demand:

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Uplift

Uplift
Uplift: Model choice

1. No evidence of time series behavior:

2. Evidence of correlation between different hours, but no common behaviour: panel approach (as for shadow price analysis)
Results

1. Wind never significant (for any hour of the day)
2. Strongest effect is fuel price
3. Different robustness checks
   - Uplift in levels regressed on wind, demand and availability changes: wind changes do not affect the uplift level
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Studied Single Electricity Market of Ireland:

▶ Little interconnection with other systems (at least up to 2012)
▶ Compulsory pool system (comprehensive data)
▶ Generators have to bid marginal cost
▶ Doubling of wind installed in 4 years analysed

Findings:

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Future Work

Future work: analyse effect of wind on constraint payments to generators.

- Does more wind make electricity more costly to final consumers?