A parsimonious fundamental model for wholesale electricity markets - Analysis of the plunge in German futures prices

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Motivation: German wholesale power prices have dropped

Power prices declined by up to 40 %
Apparent only brief impact of nuclear policy reversal after Fukushima

Currently Cal-15: 32.00 Euro/MWh

Source: BNetzA (2014)
Second look: a steep decline in the value of the Cal-14 future

How did expectations change between 2007 and 2013?

Is this development driven by the increase in renewable generation?
Question: What has happened in the meantime?

Goal: Reconstruction of Q4 2007 and Q4 2013 prices for Cal-14

- Use of a parsimonious fundamental model
- Determine 2007 and 2013 expectations for fundamentals’ values in 2014
- Decomposition of price impacts due to changes in
  - Renewable penetration
  - Conventional capacities
  - Fuel prices
  - CO2 prices
  - Demand
Parsimonious fundamental model

- Computation of expected hourly prices
  - Demand side
    - Hourly demand profile with constant shape scaled with annual demand
    - Subtraction of renewable hourly profiles scaled with annual amounts
  - Supply side
    - Piecewise linear supply stack
    - Based on estimates of minimum and maximum efficiency per technology class
    - Correction for must-run, partly temperature dependent CHP production
  - Exports/Imports
    - Regression-based hourly estimates: demand, RES infeed, baseload plant availability

Intersection of supply and demand yields price, as set by the marginal plant

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Reconstruction of expectations

- **Demand**
  - Extrapolation of demand growth of preceding three years

- **Renewables**
  - Mid-term forecasts of grid operators

- **Conventional capacities**
  - BMU Leitstudie 2007, manually adjusted for nuclear phase-out

- **Fuel and CO2 prices**
  - Myopic expectations beyond the far end of the forward curve

<table>
<thead>
<tr>
<th>Information basis:</th>
<th>Q4 2007</th>
<th>Q4 2013</th>
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<tbody>
<tr>
<td>Expectation for:</td>
<td>2014</td>
<td>2014</td>
</tr>
<tr>
<td>Load TWh</td>
<td>643,8</td>
<td>603,7</td>
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<tr>
<td>Solar TWh</td>
<td>5,93</td>
<td>36,60</td>
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<td>Wind TWh</td>
<td>53,92</td>
<td>56,28</td>
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<tr>
<td>Cap GW</td>
<td>120,6</td>
<td>117,1</td>
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<tr>
<td>Coal EUR/MWh</td>
<td>10,19</td>
<td>8,70</td>
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<tr>
<td>Gas EUR/MWh</td>
<td>27,31</td>
<td>29,37</td>
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<tr>
<td>CO2 EUR/t</td>
<td>24,92</td>
<td>4,90</td>
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</tbody>
</table>
Validation of Parsimonious Model

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Expectations for:</td>
<td>2014</td>
<td>2014</td>
</tr>
<tr>
<td>Phelix Base Future</td>
<td>61.30</td>
<td>37.64</td>
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<tr>
<td>Fundamental</td>
<td>63.42</td>
<td>36.13</td>
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<tr>
<td>Model Price</td>
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Result: impact of expectation changes on base price

Ceteris paribus approach: individual factor updated from 2007 to 2013 value
Result: operating margins of power plants

- Power plants as strip of European options
- without technical restrictions & personnel costs
- Impact varies across considered factors:

![Bar chart showing operating margins of power plants across different factors and technologies.](chart.png)
Conclusion

- The drop in 2007-2013 wholesale electricity prices driven by fundamentals
  - Model able to capture impact factors and replicate prices

- Analysis of individual factors finds
  - Emission price drop as largest single factor, demand and renewables follow
  - Combined effect of all factors larger than sum of individuals
  - Feedback effect between RES extensions and CO2 price drop?

- Slightly different result for plant operators
  - Load uncertainty large factor, fuel prices impact ambiguous

- Source of electricity price drop and loss of plant profitability not equivalent
Thank you for your attention

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Parsimonious fundamental model - overview

- Conventional generation capacities
- Fuel & CO2-prices
- Variable costs
- Temperature profile
- CHP-Must-run
- Merit Order
- Imports/Exports
- Expected hourly prices
- Residual Load
- Load
- Renewables
- Future prices

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