Efficiency of Contracts for Differences (CfDs) in the Nordic Electricity Market

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Outline

1. Motivation – Why study EPADs?

2. Research agenda
   - Risk premium, role of hydro, efficiency

3. Study results
   - Risk premia statistically significant
   - Limited efficiency of EPADs
   - Market maturity matters

4. Implications & limitations
Why study EPADs?

Market/Policy
- EPADs to facilitate the achievement of European Internal Energy Market (IEM)
- Spatial and temporal price variations a reality

Research
- Spatial price risks in electricity markets
- Efficiency and determinants of realized risk premia in forward markets
- Mixed results on CfD’s efficiency
Research agenda

1. *Ex-post* risk premia
   - significance, direction, and magnitude
   - location, delivery period, and time-to-maturity

2. Underlying factors on risk premia
   - open interest (liquidity), time-to-maturity, zone splitting
   - water availability in the hydro reservoirs

3. Integration between EPADs price and spot price difference
   - VAR model
   - Granger causality, impulse response, variance decomposition
Locational price spreads
Locational price spreads
FI (Helsinki) and NO1 (Oslo)
Open interest: volume GWh and area
Open interest: number of contracts and types
Hydro reservoir levels
Impact of hydro on area price spreads

- 2000-13 sample
- Sweden splitting in 2011 insignificant
- Finnish hydro insignificant in Aarhus and Oslo, but significant in Copenhagen

Compared to shorter sample 2001-06:
- Area price spreads tend to be on average larger (higher constant
- Response of price spread to hydro level deviations (especially in Norway and Sweden) tends to be stronger (higher coefficients)
Time-to-maturity

- Average risk premium = constant + beta * time-to-maturity + error term
- H: Risk premia are a negative function of time-to-maturity (beta<0)

- The average risk premium at the expiration date statistically different from zero

- However, many equations have an insignificant coefficient on time-to-maturity

- Consistent results for: Aarhus/year, Copenhagen/season and year, Helsinki/year, Luleå / month, quarter and year, Malmö/month, Olso/season and quarter, SE3/month, quarter and year, Sundsvall/month and year, Tallinn/year, and finally Tromsø /quarter
Time-to-maturity: Monthly EPADs
Vector Autoregression Model

- We examine the relationship between spot and forward markets to test the efficiency of EPADs

- Consecutive monthly futures EPAD prices, 1 month to maturity, and the area spot price differences (area price – reference system price)

- Monthly EPAD contracts
  - The highest price variability, shortest-term delivery period, lower forecasting errors of market participants
  - One of the most liquid contract types

- Granger causality
- Impulse response functions (IRF) - direction of the causality effects
- Variance decomposition - magnitude of the causality
VAR results

- **Granger causality** – we reject the null hypothesis for all except:
  - Sweden 4 (Malmö) in both directions
  - Norway 3 (Tromsø) in EPAD to spot price direction
    - the interdependence of spot and future price seems limited
    - past changes of futures and spot prices do not contribute to the prediction of the other variable

- **Impulse response functions (IRF)**
  - significant positive effect of *spot price shocks on EPAD futures* for NO1, FI, SE3 (10 days), and with shorter significant duration for DK2 (7 days), DK1 (5 days)
  - Significant positive effect of *EPAD futures prices on the spot price differences*, especially pronounced for NO1, DK2, and with fluctuating duration and magnitude for FI, SE3, SE1, SE2, and DK1 (≈ 5 days).

- **Variance decomposition**
  - Spot prices in DK1, NO1, and SE3 respond most strongly to EPAD futures shocks. Likewise, EPAD prices respond most strongly to spot price shocks in NO1, FI, and SE3
Direction & magnitude of shocks

<table>
<thead>
<tr>
<th>Price area</th>
<th>Variation in the spot price explained by a shock in the EPAD price</th>
<th>Variation in the EPAD price explained by a shock in the spot price</th>
</tr>
</thead>
<tbody>
<tr>
<td>DK2</td>
<td>4,2%</td>
<td>3,6%</td>
</tr>
<tr>
<td>FI</td>
<td>2,8%</td>
<td>5,7%</td>
</tr>
<tr>
<td>NO1</td>
<td>12%</td>
<td>10,7%</td>
</tr>
</tbody>
</table>

Response of NO1_DSPOT to NO1_MF

Response of NO1_MF to NO1_DSPOT
Implications

- **Risk premia** are an important part of EPAD prices
  - deviation of the water level in hydro reservoirs from its historical median impacts the local area prices, the system-wide price, as well as the difference of the two prices

- Larger price spreads and larger response to hydro levels changes => indirect evidence of higher price variation on the Elspot market

- Negative relationship between risk premia and **time-to-maturity** partially confirmed

- **Market maturity** may be the main driver as efficiency seems to increase with longer trading history (Helsinki, Stockholm, Oslo)

- Proportion of **fixed price contracts** in retail market
Limitations

- Ex-post approach to risk premia
  - Price of risk vs. error in rational expectations (Redl & Bunn, 2013)
- Accounting for transaction costs (Wimschulte, 2010)

Next Steps

- Role of skewness (+) and variance (-) in risk premia (Bessenmbinder & Lemmon, 2002)
- Further determinants of risk premia – market power, price spikes in spot market....
Thank you!

Questions?