When supply meets demand: the case of hourly spot electricity prices

Alexander Boogert

Commodities 2007
London, 17-18/01/2007

Essent Energy Trading, the Netherlands
Birkbeck College, University of London, Commodities Finance Centre
alexander.boogert@essent.nl
Goal

• Establish simple relation between publicly available fundamental drivers (supply and demand) and hourly spot electricity prices
• As market design is different between markets, create model for general structure and specify relations for particular market
Which type of model to choose?

Reduced-form model
- Popular in academic literature
- Mathematically tractable
- Parameter estimation

Fundamental model
- Popular in industry
- Data intensive
- Relation to market prices

Hybrid model:
Use additional information besides price time series
What is the state of the market?

**Desired**
Information about supply and demand elasticity

**Available**
Amount and price of power traded on day-ahead market (DAM)

**Note**
A relation between amount and price of power traded on DAM exists in certain (but not all!) markets

In NL: day-ahead market 20% of consumption, but still important benchmark
Demand elasticity

- Normal consumers can be called price insensitive
- But certain large consumers can temporarily shut-down (and sell an interruptable contract)
- No public information available on such contracts

Result
- Most models assume demand inelasticity
- Explicit approach taken in Fezzi&Bunn (2006)
- Our approach implicitly picks up demand elasticity
Supply elasticity

**Idea 1: total offered capacity in day-ahead market**
Possible if relation between amount and price on DAM exists and data is published without delay

**Idea 2: compose estimate for total available capacity**
Drivers are:
- **Availability:** several European countries (NL, GER, UK) started to publish day-ahead estimates
- **Import/export capacity:** usage depends on market design (especially timing of auction)
- **Technical constraints:** creates a link between hours
Relation between supply, demand and spot price

We consider reserve margin = 1 – demand/available capacity (closely related to capacity utilization)

Economic interpretation:
• Spot price rises for decreasing reserve margin
• Variability around average rises for decreasing reserve margin

Two natural alternatives:
Supply-demand ratio or absolute supply-demand
Our approach and applications

Our approach
• Estimate relation without imposing functional form
• Consider one-dimensional relation (can be extended)

Contrasts with
• Data mining techniques like e.g. neural networks
• Functional form models

Applications
• Price indicator: forecast price or probability of spike
• Calibration: transform fundamental into market prices
• Forward risk premium: study how types of risk are present
Overview Dutch market

Current situation
- TenneT manages network and organizes DAM (APX)
- Import/export capacity mainly used for import
- Timing: auction import/export capacity before APX
- Price differences can occur between markets

New development
- Market coupling between NL, BEL and FR
- Timing: no longer explicit auction of capacity
- Results in same price if there is no congestion
Available data in the Netherlands

- TenneT available capacity (TAC)
- National load (NL)
- Maximum import/export (MIE)
- Realized import/export
- Wind power
- Real-time prices and volumes
- Regulating power

Ingredients for reserve margin = 1 – demand/av cap
Available capacity = TAC + MIE
Demand = NL
Overview

In the next slides we present graphs from Dutch market

• Data sample: 01/10/2004 to 17/06/2006
• All graphs use the complete sample
• Compromising all hours from both week and weekend
Ingredients for reserve margin over time

Load

Available capacity

Import (max and realized)
APX price and reserve margin over time

APX

Reserve margin
Scatterplots: APX versus ...

Reserve margin

Load

Available capacity
Forecast price and uncertainty

Approach: create intervals of width 0.05, take percentiles of data within each interval
Probability of a spike

Approach: probability spike defined as relative number of observations > 90 euro
How to draw a curve?

1. Use dashed lines for boxed sections.
2. Use blue lines for b-splines.
3. Use red lines for smoothed sections.

Boxed mean with small width:

- APX [Euro/MWh]
- Reserve margin
- Nr. observations

Nr. obs.:

- Reserve margin
- Nr. observations
Data spikes for medium reserve margin

Number of hours on specific day with APX>200 and reserve margin < 0.3
Summary from graphs

Two problems
- Double hump (we expect monotonic decrease)
- Data already spikes for medium reserve margin

Potential reasons
- Unreliable estimates for available capacity by TenneT?
- Bad assumption on total capacity?
- Data sample is not homogenous?

Expect difficulties for reserve margin
- Weekend days, especially Sunday due to start-up costs
- Night hours due to must-run units for heat
- Highest peak hours due to peak-shaving

Next: test stability over subsets and time
Stability over subsets?

Split data sample
- Day into peak and off-peak
- Peak into weekend-peak, shoulder and super-peak
- Year into summer and winter

Conclusions
- Peak and off-peak prices are in line though off-peak prices fall below peak-prices for lower reserve margins
- Weekend-peak < shoulder < super-peak for most reserve margin levels
- Conclusion sustained for summer-winter split
Conclusion

- Reserve margin matters in spot price modeling
- Reserve margin can be used to predict price spikes and/or in development of fundamental model
- Initial results on stability over time promising. Advise to split data between week and weekend, while split of season is not necessary
Further reading

A paper describing more details from this presentation will be released on the website
http://www.ems.bbk.ac.uk/cfc/publications.htm

Alexander Boogert and Dominique Dupont,
When supply meets demand: the case of hourly spot electricity prices