Day-ahead market price volatility analysis in deregulated electricity markets.

M. Benini, A. Venturini

CESI - T&D Network
Milan, Italy

P. Pelacchi, Member, IEEE, M. Marracci

Electric Systems and Automation Dep.
University of Pisa, Italy
INTRODUCTION

- Price volatility is a measure of the dispersion in prices observed over a time period.
- Price volatility in the electricity market is rooted in hourly, daily, weekly and seasonal uncertainty; the fundamental market drivers are demand variations, fuel prices, generating units availability, hydro generation production, etc..
- Price volatility is extremely important for proper risk management.
EXPECTED PRICES CONCEPT

- In an electric market there is a strong relationship between price and load; load is less random than price.

- If there is a linear correlation between load and price then:

\[
P_{d,i}^{\text{exp}} = P_{d-\text{comp},i} \cdot \frac{L_{d,i}}{L_{d-\text{comp},i}}
\]

- Comparable days for Sunday, Monday, Tuesday, Friday and Saturday are the same days of the previous week.

- Comparable days for Wednesday and Thursday are the day-before days.
EXPECTED PRICES CONCEPT

Real (continuous) and expected (dashed) prices; Spain 1999
EXPECTED PRICES CONCEPT

- Let’s define the variable $u_k$ as

$$u_k = P_k - P_k^{\text{exp}}$$

- where:
  - $P_k$ is the effective price at hour $k$
  - $P_k^{\text{exp}}$ is the expected price at hour $k$
EXPECTED PRICES CONCEPT

$u_k$ variable; Spain 1999
Finally we define **price volatility** as the standard deviation of $u_k$

$$\sigma = \sqrt{\frac{\sum_{k=1}^{N} (u_k - \bar{u})^2}{N - 1}}$$

- where is $\bar{u}$ the mean value of the $u_k$’s
In order to calculate the price volatility trend over one year, the following *two-weeks volatility* has been defined (336 values starting from hour $j$)

$$
\sigma_{j, two} = \sqrt{\frac{\sum_{k=j}^{j+335} (u_k - \bar{u})^2}{335}}
$$
PRICE VOLATILITY DEFINITION

Price volatility; Spain 1999

![Graph showing price volatility for Spain in 1999 with units in € Cent/kWh and hours on the x-axis.](image)
PRICE VOLATILITY DEFINITION

- In the study carried out it has been introduced, for convenience, also a *percent volatility* defined as

\[
\sigma_{j,\text{percent}} = \frac{\sigma_{j,\text{two}}}{P_{j,\text{two}}} \cdot 100
\]

- where

\[
P_{j,\text{two}} = \frac{\sum_{i=j}^{335+j} P_i}{336}
\]

- is the two weeks spot price moving average referred to hour \( j \)
PRICE VOLATILITY IN SPAIN

Two-weeks average prices
Spain 1999/2000

Year 1999
Year 2000

Two-weeks price volatility; Spain 1999/2000

Percent price volatility; Spain 1999/2000
REMARKS ON SPANISH MARKET

- This market shows the lowest price volatility among the markets analyzed. This behavior is mainly due to:
  - high amount of installed capacity (in 1999 over 37%, in 2000 over 32%)
  - high stability of fuel prices (nuclear 35%, coal 43%)
  - Possible collusive behavior among generating companies limited by the stranded costs refund system adopted: the higher the market price, the lower the stranded costs refund
PRICE VOLATILITY IN CALIFORNIA

Two-weeks average prices; California 1999/2000

Two-weeks price volatility; California 1999/2000

Year 1999

Year 2000

Percent price volatility; California 1999/2000
REMARKS ON CALIFORNIA MARKET

- In both analyzed years, this market shows the highest stability in the firsts months. Price volatility increases strongly in summer. This behavior is mainly due to:
  - gap reduction between installed capacity and peak load in summer months
  - reduced water reserve level in autumn months due to high consumption during previous period
- Both situations aids generating companies applying market power
PRICE VOLATILITY IN UK

Two-weeks average prices
UK 1999/2000

-----------------------------------------------
| Year 1999 | Year 2000 |
-----------------------------------------------

Two-weeks price volatility; UK 1999/2000

Percent price volatility; UK 1999/2000
**REMARKS ON UK MARKET**

- In 2001 started the New Electricity Trading Arrangement (NETA)
- Old UK electricity spot market shows highest average prices and medium price volatility.
  - This market was characterized by:
    - one side offer (inelastic demand)
    - low transparency due at complex market rules and consequently possible collusive behavior among producers
    - Capacity Payment mechanism
REMARKS ON UK MARKET

- There is a strong correlation between price volatility and Capacity Payment.

CP Daily Moving Average ; UK 2000

Two-weeks price volatility; UK 2000

- This correlation shows that availability of generating capacity is one of the main drivers of price volatility in UK

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REMARKS ON PJM MARKET

- Especially in summer PJM electricity market shows high exposure at price spikes. This behaviour is mainly due to:
  - low amount of installed capacity (in 1999 only 9.6%; in 2000 only 11%)
  - yearly peak-load period in summer
  - Price spikes cause very high uncertainty captured by calculated price volatility spikes.
CONCLUSIONS

- On the basis of an original price volatility definition a quantitative analysis of price volatility in four spot markets has been carried out (Spain, California, UK and PJM)
- A qualitative analysis of market driver on pricing has also been developed. It has been observed that lack of generating capacity involve high price volatility particularly in peak-load periods
- Analytical models oriented to day-ahead spot price forecasting are under developing starting from this framework.