



Electrabel

GDF SUEZ

Power and Gas Markets

Challenges for Pricing and Managing Derivatives

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Outline

- Power Markets:
 - Spot Market
 - Forward Market
- Gas Markets
- Derivatives
 - Plain Vanilla Products
 - Exotic Products
- Conclusions

POWER MARKETS

Power Market

- Electricity is unique:
 - cannot be stored (flow commodity)
 - No flavours
 - Transport is limited
 - Production = Consumption (auction)
- Trading Power is relatively new
- 2 Different Markets
 - Spot Market
 - Forward Market

Power Markets – Spot Market

- Day-ahead auction per market (~country)
 - Power supply:
 - Nuclear Power plants
 - Gas-fired power plants
 - Coal-fired power plants
 - Hydro-power plants
 - Transport Capacity (import)
 - ...

Power Markets – Spot Market

- Day-ahead auction per market (~country)
 - Power demand:
 - Transport Capacity (export)
 - Industrials
 - Home users
 - ...

Power Markets – Spot Market

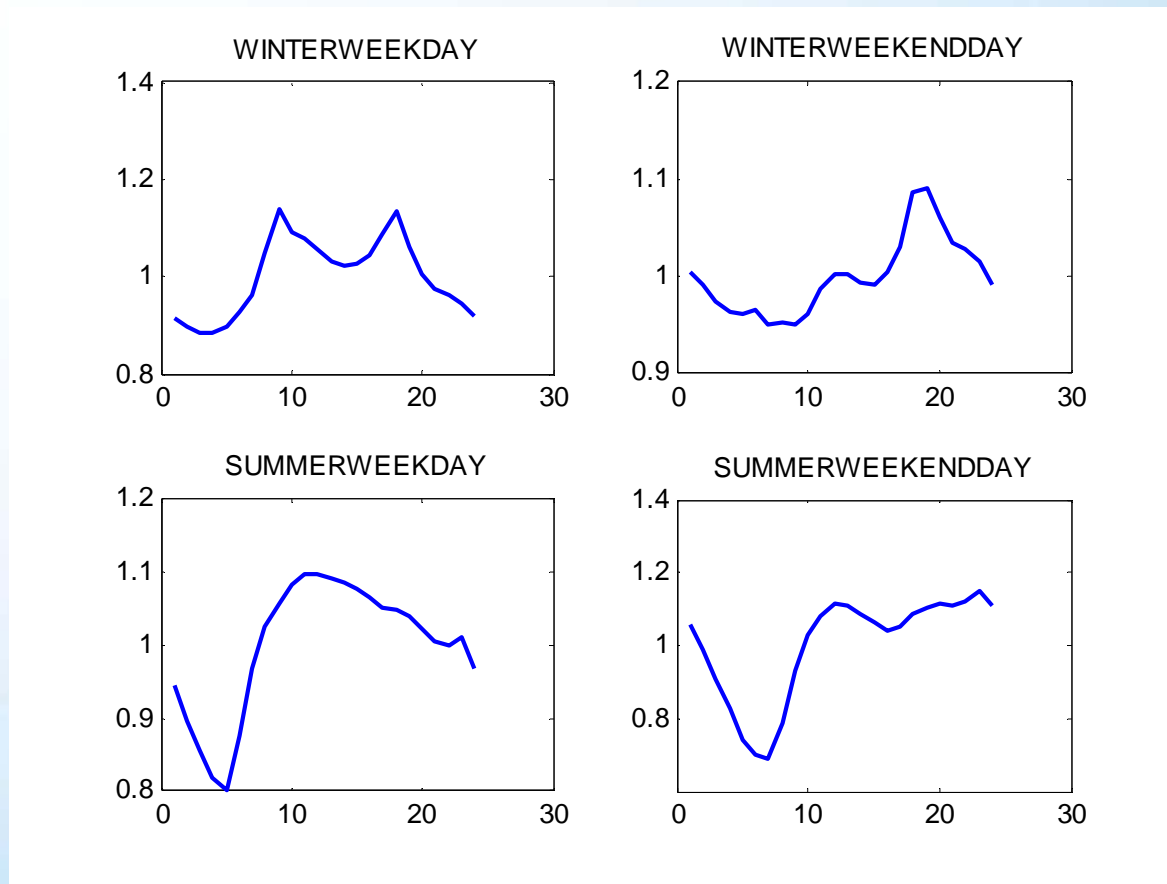
- Day-ahead auction per market (~country)
 - Auction for each hour of the next day
 - Price = (Supply meets demand)
 - Price is set by marginal cost
 - Price reflects the consumption pattern

Power Markets – Spot Market

- CASE STUDY: NORDIC MARKET
 - Considered as Very liquid
 - Hydro-driven (closest to storability)

Power Markets – Spot Market

- Day-ahead auction per market (~country)



(example: Nordic System Price Pattern)

Power Markets – Spot Market

- Intraday Price Pattern
 - Very weather-dependent
 - Depends on type of day (weekday/Saturday/Sunday/Holiday)
 - Depends on Month
 - Very volatile with respect to the ‘average’ profile
 - Unpredictable

Power Markets – Spot Market

- Time Series of the Spot Price (Nordic)

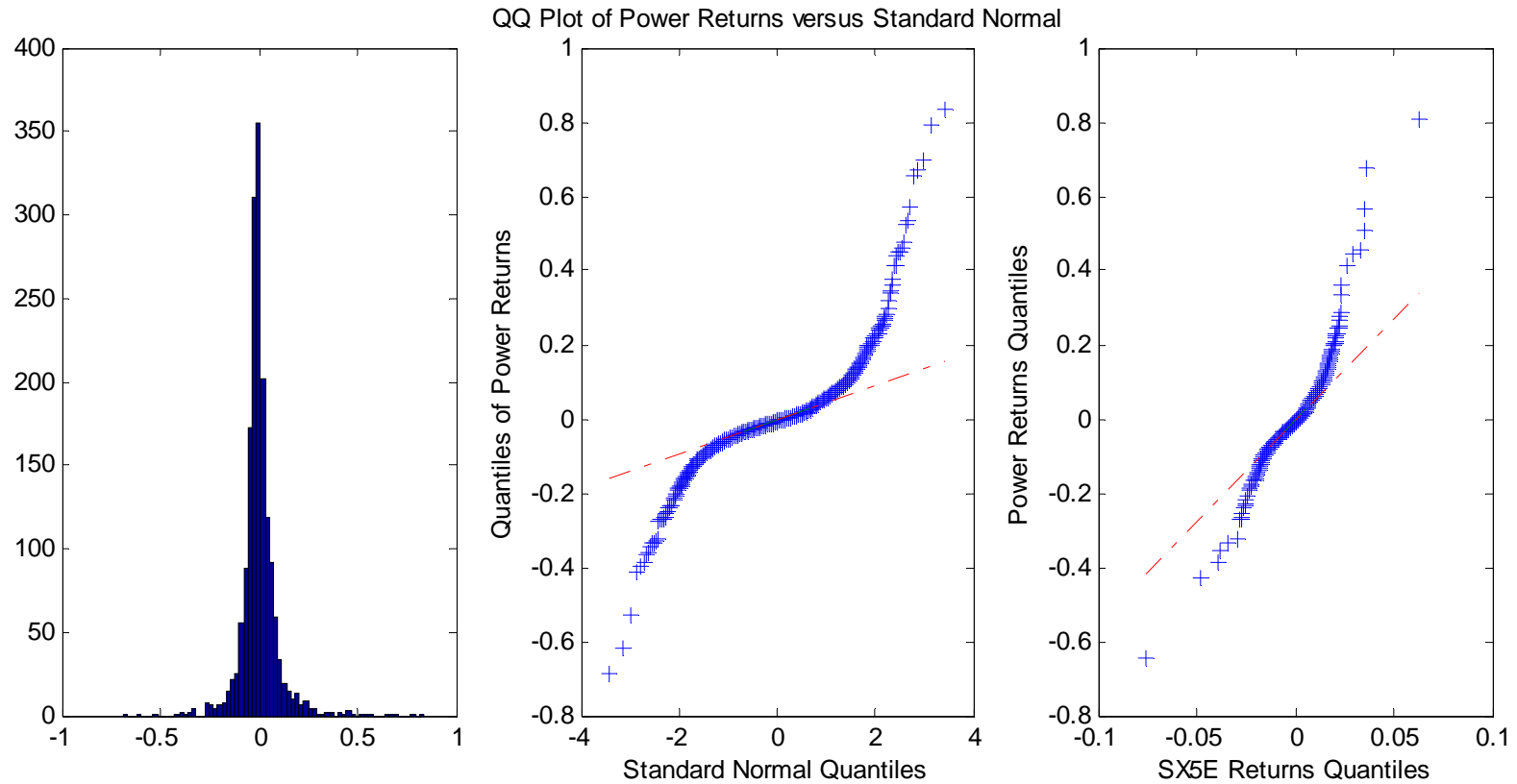


Power Markets – Spot Market

■ Features:

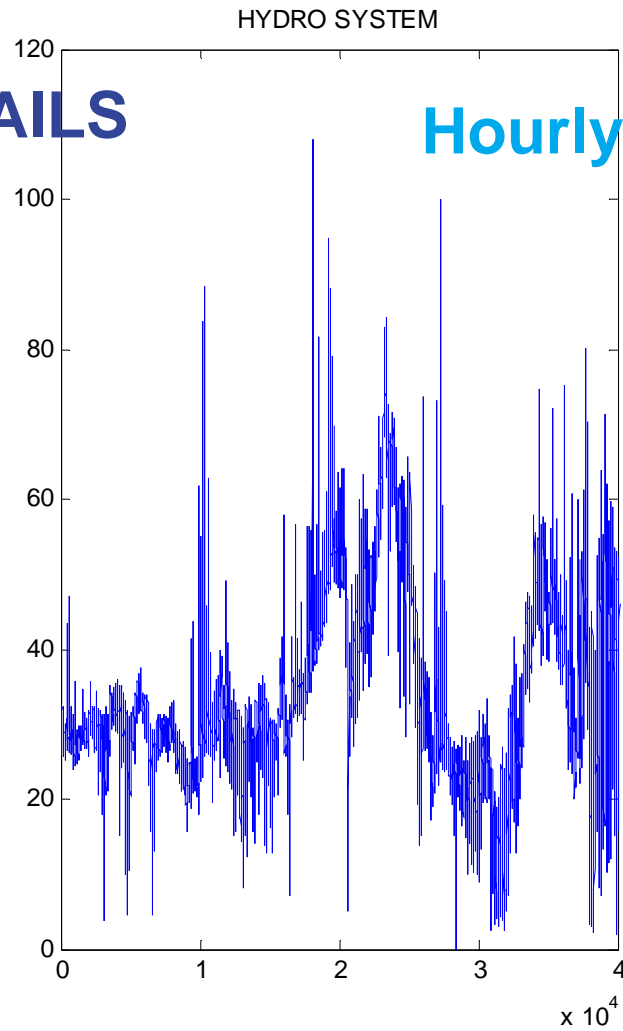
- Very FAT tails
- Prices expected to be
 - Higher in the winter / Lower in the summer
 - Higher during the Week / Lower during the weekend
 - Higher During PeakHours / Lower during offpeak (night)
- Mean-reversion(?)

Power Markets – Spot Market



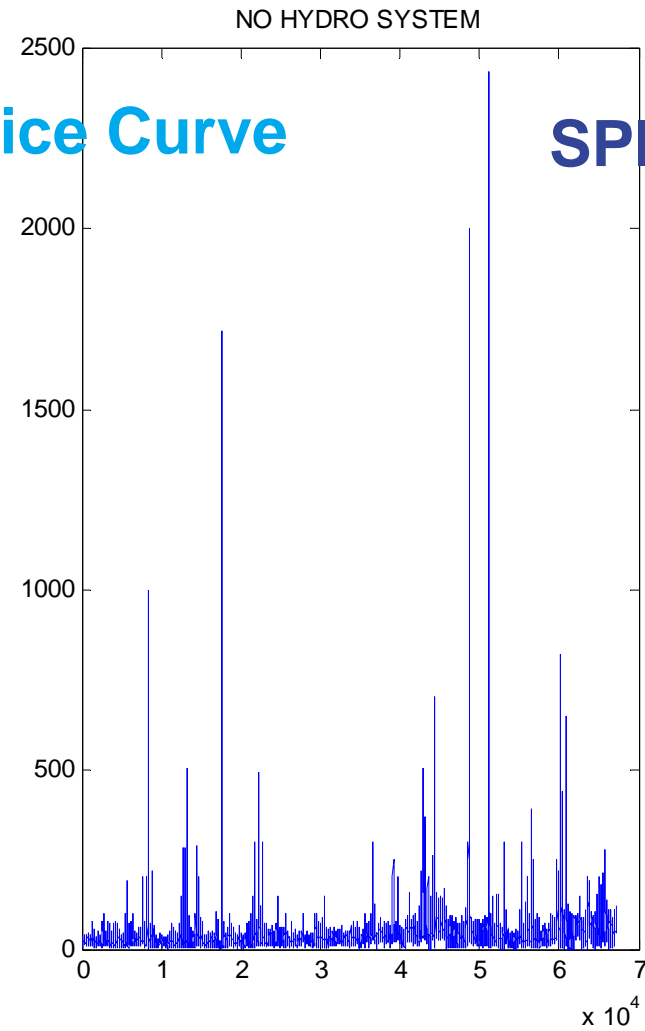
Power Markets – Spot Market

FAT TAILS



Hourly Price Curve

SPIKES



Power Markets

- The need to manage Risk on the Spot Market
led to
the development of the Forward Market

Power Markets – Forward Market

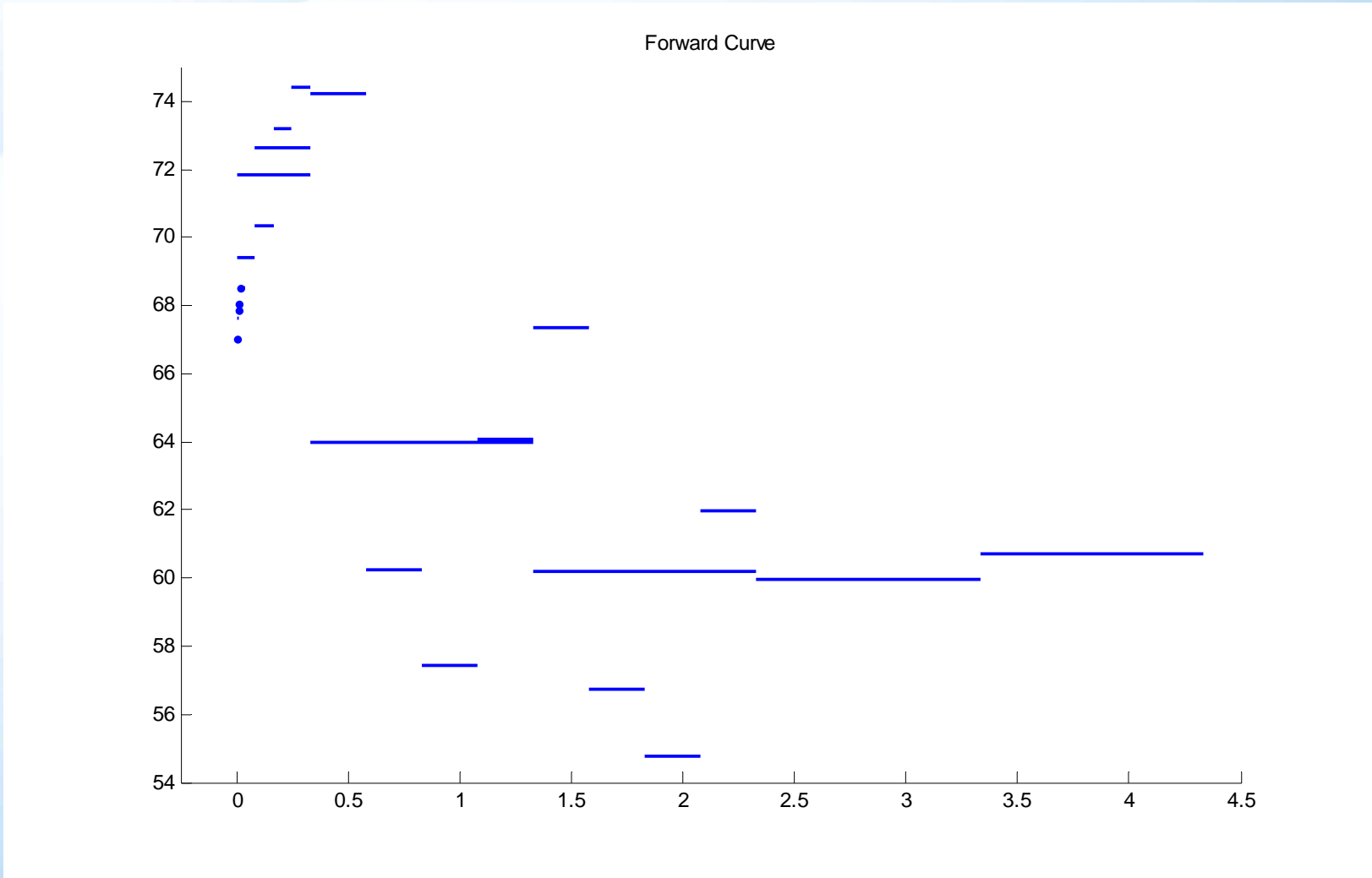
- Forward Contracts $F(t, T_1, T_2)$:
 - Price at time t for the commodity to be delivered (in a constant 'volume' during the entire period $[T_1; T_2]$)
 - $[T_1; T_2]$ = delivery period
 - Payment done during the delivery period, usually settled on a monthly basis (swap)
 - Price is fixed and constant during delivery
 - Forward price is an estimate of the AVERAGE realised Spot price during delivery period.

Power Markets – Forward Market

- Delivery period is bucketed into
 - Days – Weeks on the short-end of the curve
 - Months / Quarters
 - Years

- Cascading Mechanism:
 - 1 Year → 4 Quarters
 - 1 Q → 3 Months
 - 1M → 4 Weeks
 - 1W → WEEKEND + DAYS

Power Markets – Forward Market



Power Markets – Forward Market

- Seasonality is very obvious in the Forwards
- Forward Market Organised in
 - Exchange (Futures)
 - Brokered OTC Market (very liquid and transparent)

Power Markets – Forward Market

- Some numbers on the Nordic Market:
 - First liberalised Market in Europe
 - About 150 players in the Forward Market
 - About 15 (active) players in the Vol market
 - About 3-5 option trades per day

GAS MARKETS

Gas Markets

- Gas is storable to some extent
 - Pipelines
 - Day-storages
- No Hourly market
- No spike-behaviour

- Still seasonal, still very fat tails, very physical as well

PLAIN VANILLA DERIVATIVES

Derivatives: Plain Vanilla Products

- Option Expires before delivery period starts
- Power:
 - Options on Futures (Exchange)
 - Swaptions: Options on the 'Forward' (OTC)
 - 'Liquid' Markets: Nordpool, Germany
- Gas:
 - Options on Summer/Winter Forwards
 - Strip of Options on Summer/Winter (most liquid)

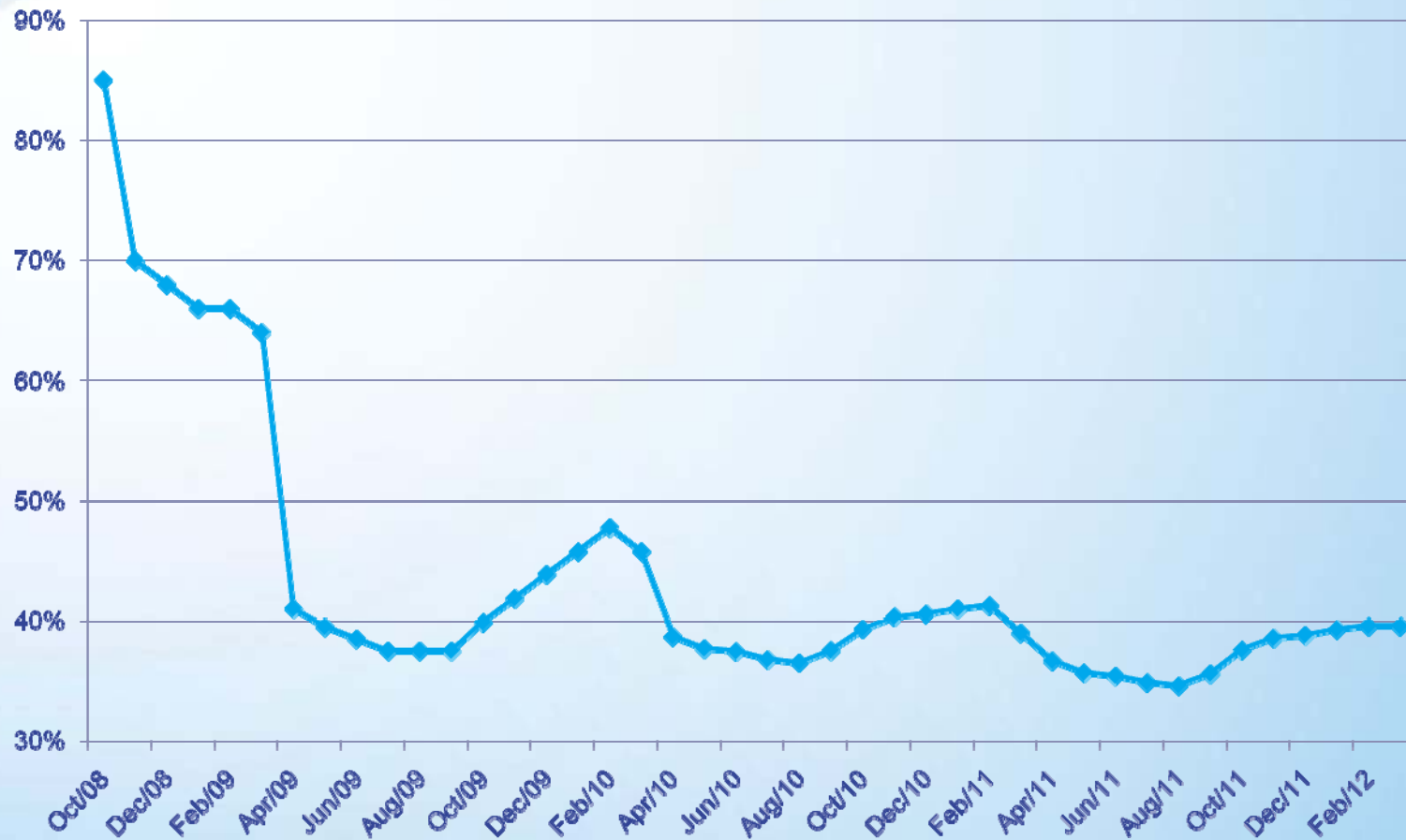
Derivatives: Plain Vanilla Products

- Study (Koekebakker and Ollmar, 2005):
 - Multifactor (geometric Brownian) forward dynamics
 - 2 factors → explain 75% of volatility of the forward curve
 - 10 factors → capture 95%
 - Low correlation between short-end and long-end

Derivatives: Plain Vanilla Products

- Typically only a few expiries per product
- Volatility 'Term Structure' refers to underlying forward curve
 - Short-end of the forward curve: HIGH VOL
 - Long-end of the forward curve: LOW VOL
- Seasonality in Volatility
 - Winter Vol (relative) high
 - Summer Vol (relative) low

Derivatives: Plain Vanilla Products



Derivatives: Plain Vanilla Products

- Challenges for the 'Plain Vanilla Options'
 - Option market is thin (implied vol quotes not always reliable)
 - Implied Vol quoted according to bad model (model for forwards rather than swaptions)
 - Bid/Offer spreads in the underlying (hedging cost)
 - Fat tails (as any market)
 - Liquidity

Derivatives: Plain Vanilla Products

- Bid/Offer spreads for Forwards:
 - Days: 0.75% - 5% (sometimes even 15%, for SUN)
 - Weeks: 1.25% - 6%
 - Months: 0.5% - 2% - 5%
 - Quarters: 0.10% - 3%
 - Cals: 0.25% - 2%

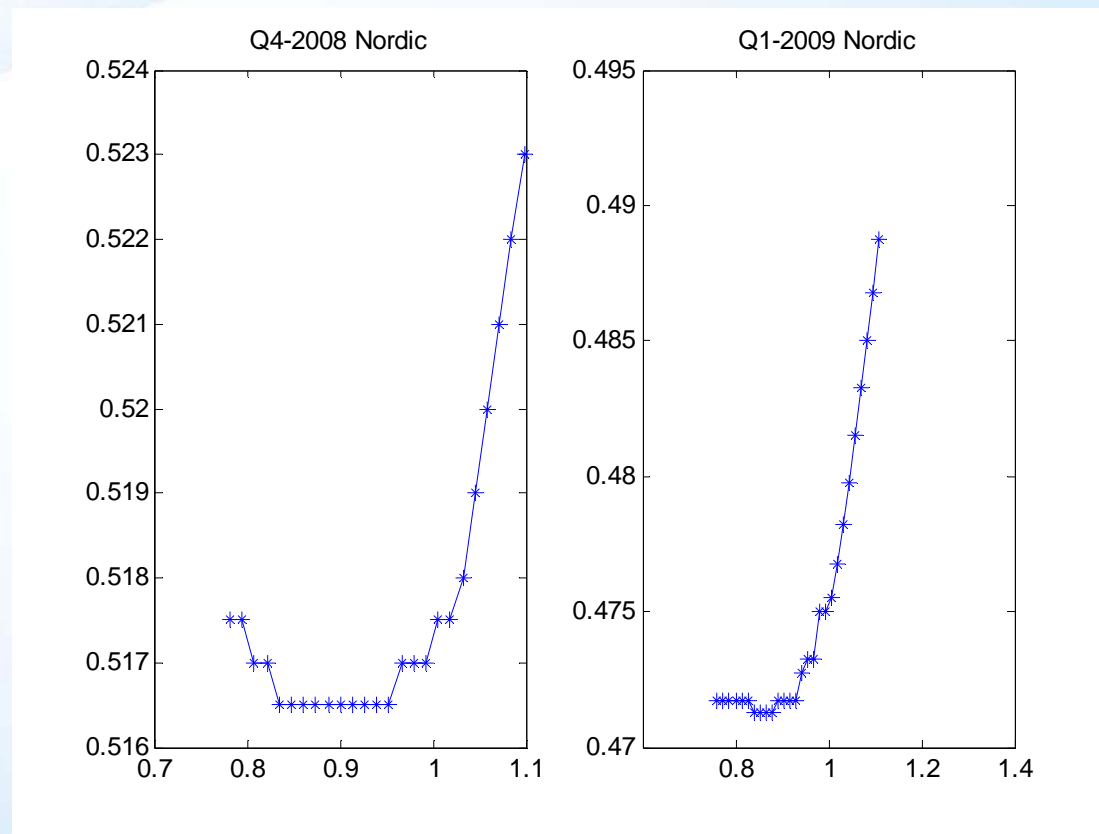
Derivatives: Plain Vanilla Products

- Liquidity in Forwards:
 - Can dry up easily and fast
 - Risk premium: implied vol is much higher than realised vol (difference about 10%)

Derivatives: Plain Vanilla Products

- Underlying does not (yet) exist
 - Strip of Options on Winter/Summer products
 - 6 Options each expiring right before Monthly-Forward goes into delivery
 - Monthly forwards may not be traded at the time of writing the option
 - Basis Risk: “Hedging of Untradable Assets,”
N. Vandaele, P. Leoni and M. Vanmaele *(in preparation)*

Derivatives: Plain Vanilla Products



- Skew is rather small
- About 15 players in the vol market

EXOTIC DERIVATIVES

Derivatives: Exotic Products

- 2 Examples and their risks:
 - Hourly Option (power)
 - Swing Option (gas)

Derivatives: Exotic Products: Hourly Option

■ Specifications

- Strip of options expiring on the SPOT market
- For each hour of the day, for each day over the period (typically 3 years), the owner has a right:
- Call/Put
- Fixed strike (can be floating as well)
- For each hour: 'nomination' or exercise has to be decided on a day-ahead basis
- Settlement can be financial or physical

Derivatives: Exotic Products: Hourly Option

- Model - Risks:
 - Year-to-Quarter-to-Month-to-Week-to-Day profile
 - Intraday profile (hourly profile)
 - Volatility on each scale

- Challenges
 - Pricing the product
 - Hedging the product (profiles cannot be hedged perfectly)

Derivatives: Exotic Products: Swing Option

- Swing Option:
 - Very complex product in an imperfect market
 - Traded very often because of physical nature of the (Gas) Market

Derivatives: Exotic Products: Swing Option

■ Specifications

- A certain volume of gas can be bought at Strike Price (Call Option)
- Strike can be fixed/floating (oil-related)
- Nomination on day-ahead (or month-ahead)
- Constraints:
 - Total Volume between V_{\min} and V_{\max}
 - Daily nomination between D_{\min} and D_{\max}
 - Monthly nomination between M_{\min} and M_{\max}

Derivatives: Exotic Products: Swing Option

■ Challenges

- Usual model risks (fat tails, stochastic vol,...)
- American features: “Do I nominate today or do I wait”
- Optimizing the nomination process within constraints
- Correlation/Comovement across the curve
- Highly dimensional: daily level (sometimes hourly)

CONCLUSIONS

Conclusions

- Derivatives in Power/Gas
 - Combination of hedgable risk and unhedgable risk
 - Discrete hedging to its fullest extent
 - Liquidity premiums
- Market is growing rapidly
- Physical nature cannot be forgotten
- Matching Spot Model and Forward Model

You've got the energy.

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