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Modelling Fundamental Drivers for the Distribution of Intraday Electricity Prices

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Outline

Increasing importance of the intraday market

- Main adjustment markets for renewables
- Commercial optimisation of flexibility (BESS, but also other flexible generation)

Modelling the intraday price distribution

- Somewhat sparse literature (has gotten better though)
- Non-gaussian, heavy tails, time-dependent volatility
- Merit-order effect of volatility + Trading activity
- Applications in forecasting, trading asset optimization, risk management → lunch break

Talk is based on joint work with Florian Ziel, published in *The Energy Journal* (2024) and *Applied Stochastic Models in Business and Industry* (2024) and some other sources noted on the page footer.

- Hirsch, Simon, and Florian Ziel. "Simulation-based forecasting for intraday power markets: Modelling fundamental drivers for location, shape and scale of the price distribution." *The Energy Journal* 45.3 (2024): 107-144.
- Hirsch, Simon, and Florian Ziel. "Multivariate simulation-based forecasting for intraday power markets: Modeling cross-product price effects." *Applied Stochastic Models in Business and Industry* (2024).

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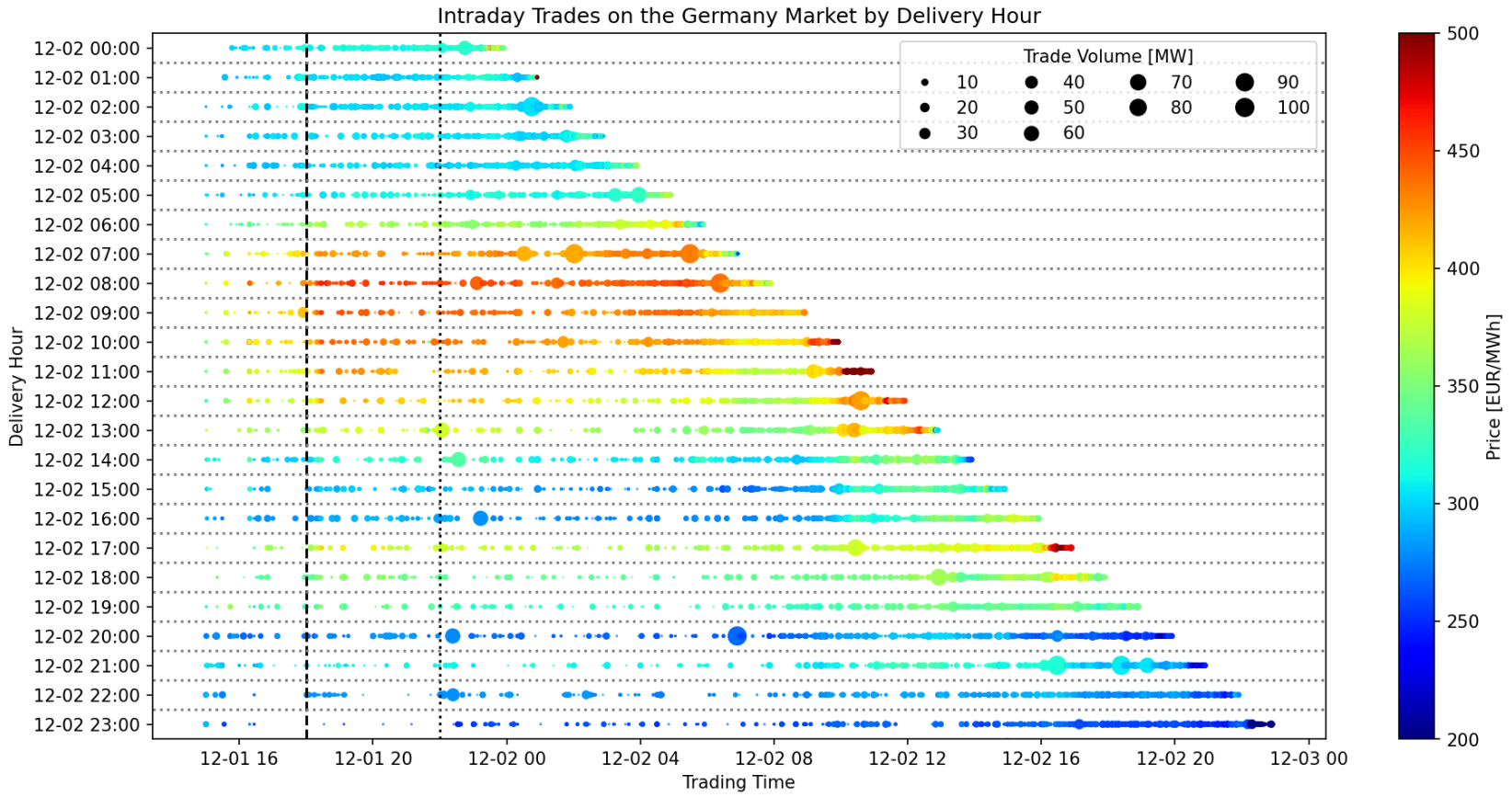
Market structure in the intraday, trading activity and prices



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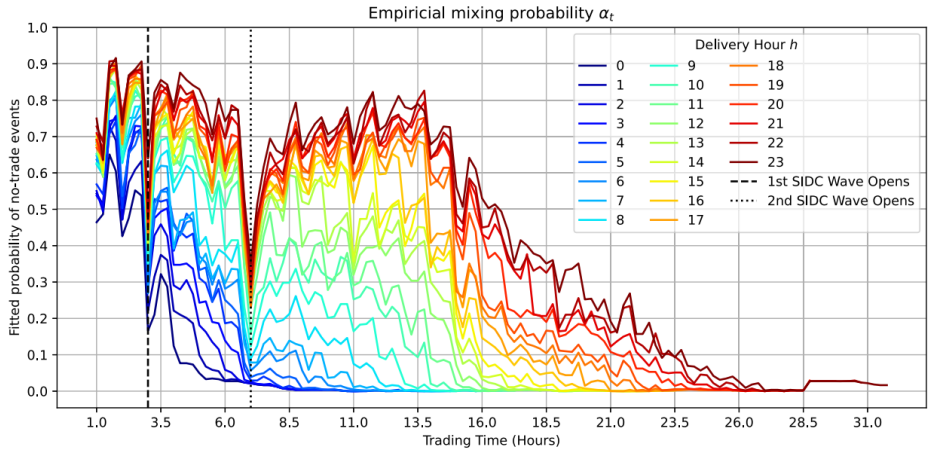
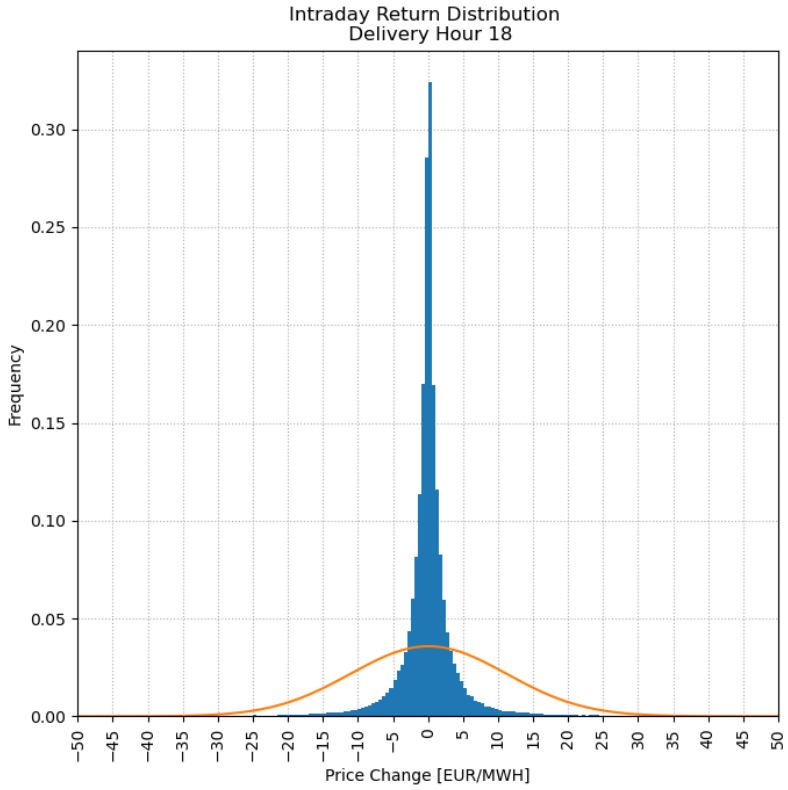
Stylized facts on the German Intraday Price Return Distribution and Basic modelling approach

- Price *return* Distribution – Price change between 15-minute sampled trading steps
- Two stage modelling approach
  1. Modelling activity
  2. Modelling the distribution

Trading activity in the intraday market by trading time
(Data from 2020)





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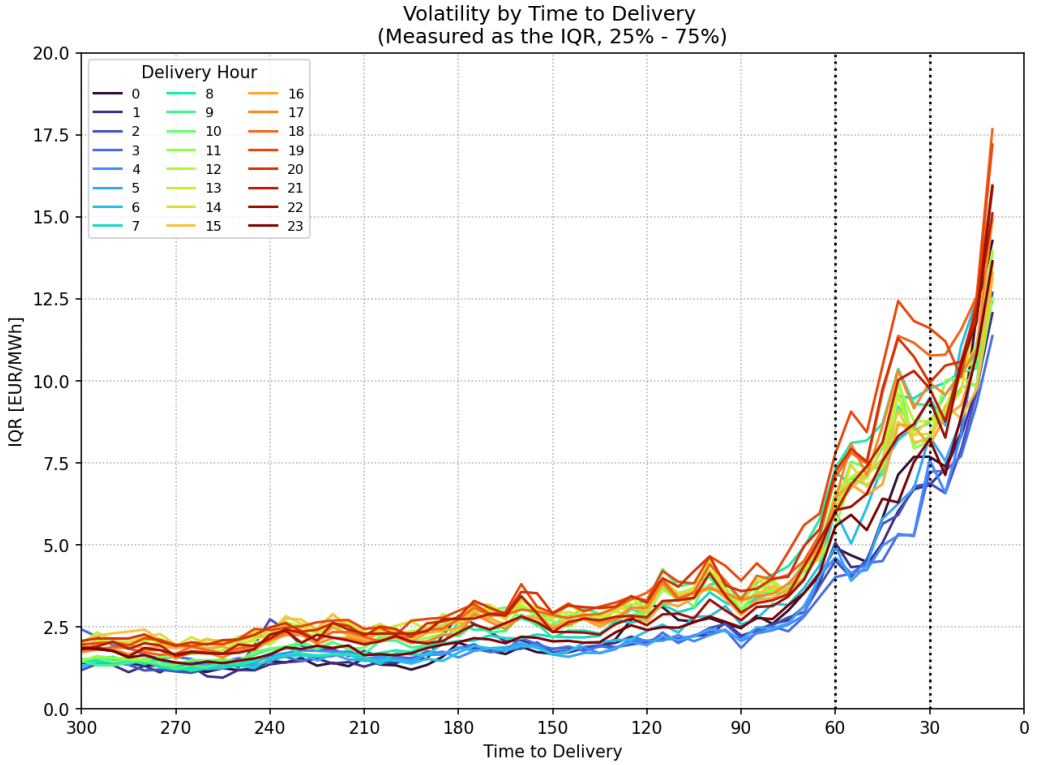
Volatility is time-varying and driven by fundamentals, trading behaviour and market design

Notes

- Volatiltiy increases towards gate closure
- Pronounced spikes around SIDC and local trading gate closure
- Modelling the effect improves forecasting performance
- SIDC cut-over used to be more distinct in the past
- Effect of SIDC closing during pan-European Intraday Auction

Data from 2022-01-01 to 2023-06-18



Adjusted Standard Deviation to IQR, Updated version of Figure 2, The Energy Journal

- Hirsch, Simon, and Florian Ziel. "Simulation-based forecasting for intraday power markets: Modelling fundamental drivers for location, shape and scale of the price distribution." *The Energy Journal* 45.3 (2024): 107-144.
- Hirsch, Simon, and Florian Ziel. "Multivariate simulation-based forecasting for intraday power markets: Modeling cross-product price effects." *Applied Stochastic Models in Business and Industry* (2024).

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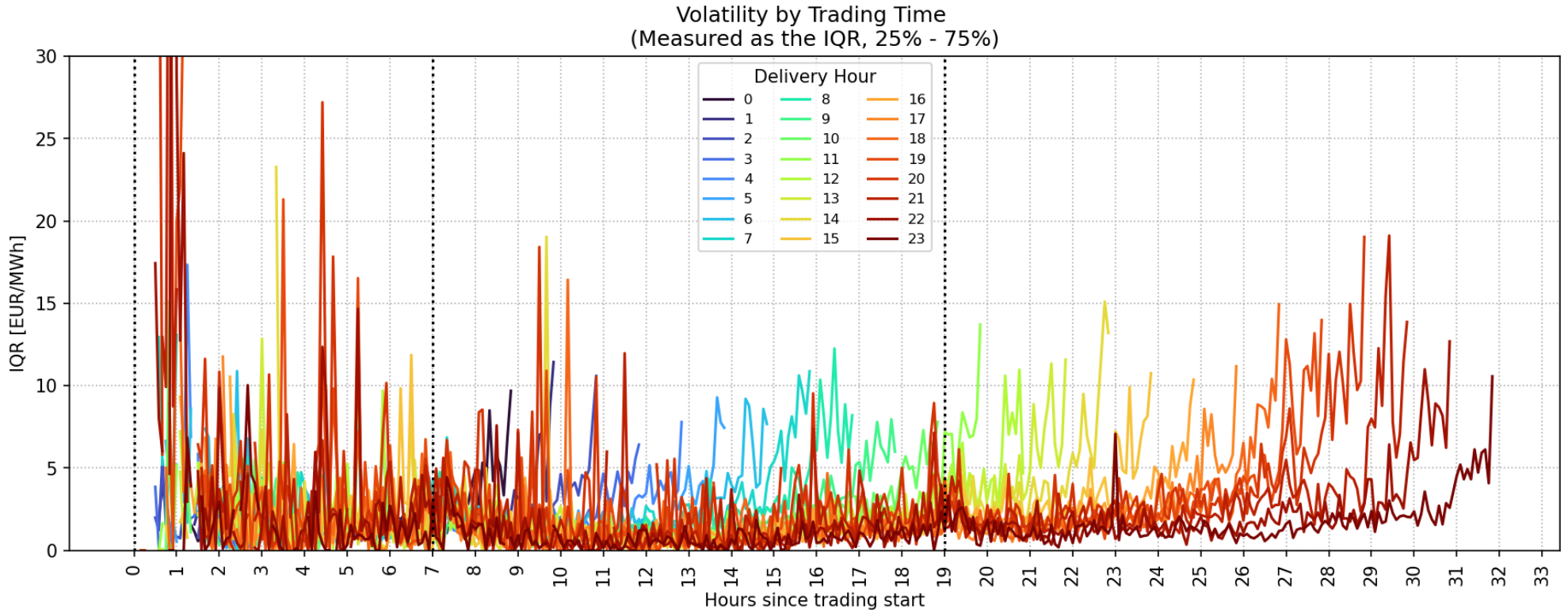
Impact of Pan-European Intraday Auctions on the intraday volatility

Data 2024-06-13 to 2024-07-03 (20 Days) – Dotted lines correspond to IDA timings



EPEX Spot (2024) – Press Release IDA Auctions (Link)

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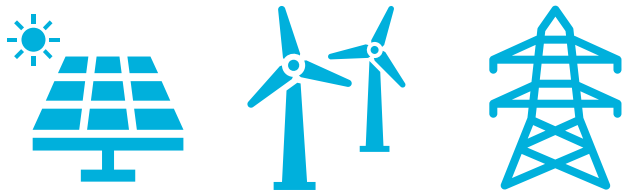
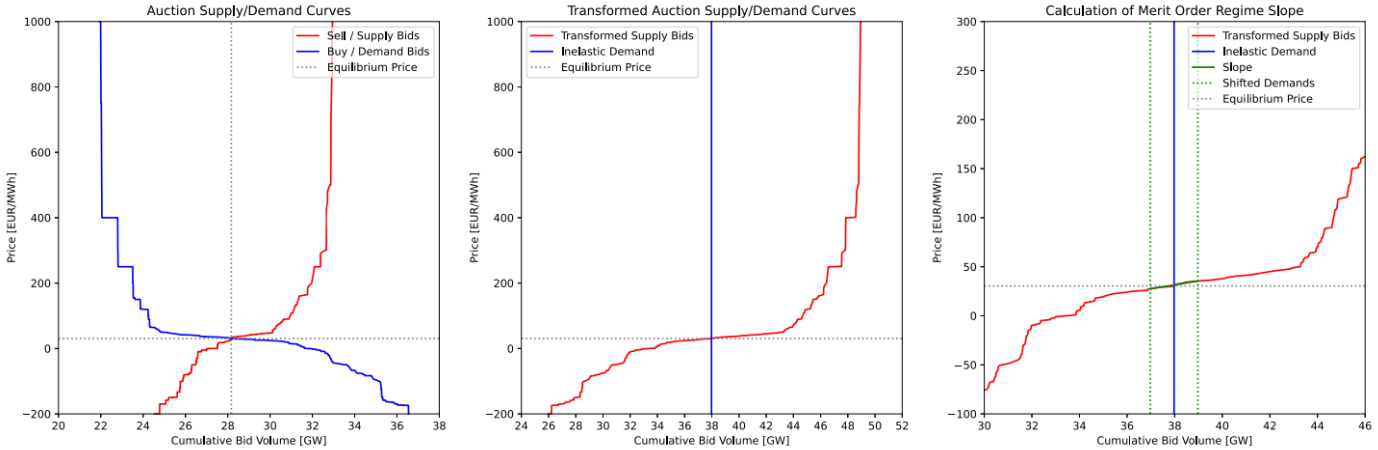
Intraday market price level is driven by renewables forecast errors and the merit-order shape

„Classic“ Fundamental Variables



- Wind, Solar, Demand forecast updates drive the price level (relative to DA, Ziel 2015)
- Weak-form Market efficiency (Narajewski & Ziel 2020a, b)
- Less important for the distribution shape

Merit-order shape



- Derive the merit-order for the intraday from the supply/demand curves at EPEX spot
- Steep merit-order regime implies that there are few plants at similar marginal costs available, hence high volatilty

- Ziel, Florian: Modeling the impact of wind and solar power forecasting errors on intraday electricity prices. In: 14th International Conference on the European Energy Market (EEM 2017). IEEE, 2017.
- Narajewski, Michał, and Florian Ziel. "Econometric modelling and forecasting of intraday electricity prices." Journal of Commodity Markets 19 (2020a): 100107.
- Narajewski, Michał, and Florian Ziel. "Ensemble forecasting for intraday electricity prices: Simulating trajectories." Applied Energy 279 (2020b): 115801.

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Intraday Products Trade in Parallel – Dependence between different delivery periods is important

Qualitative effects

- Correlation between delivery periods increases towards the end of trading
- Correlation to neighbouring products decrease with difference in the delivery hours
- Distinct SIDC opening effects – correlation low

Fitted time-dependent dependence parameters

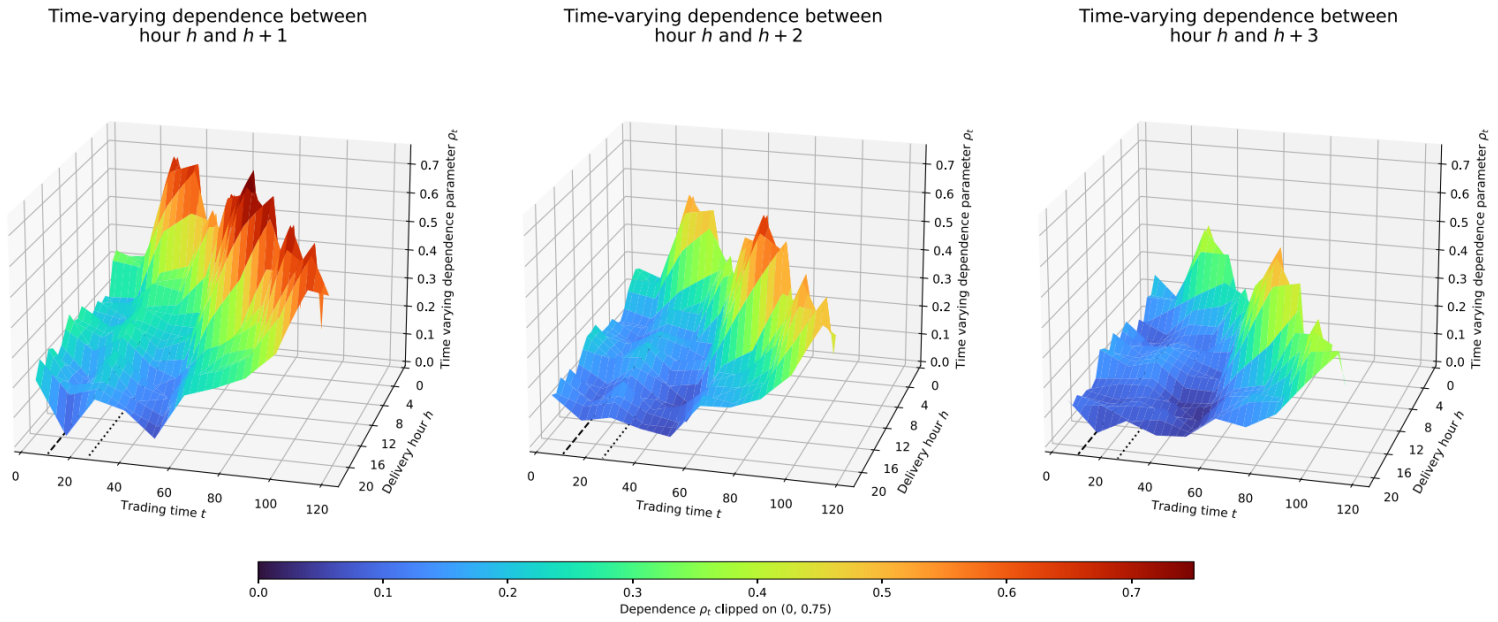

Figure 11 in Hirsch & Ziel, (2024)

Acknowledgement: Thomas Deschatre and Xavier Warin at EDF found very similiar effects with a very different modelling approach (published around the same time in 2023)

- Deschatre, Thomas, and Xavier Warin. "A Common Shock Model for multidimensional electricity intraday price modelling with application to battery valuation." arXiv preprint arXiv:2307.16619 (2023).
- Hirsch, Simon, and Florian Ziel. "Simulation-based forecasting for intraday power markets: Modelling fundamental drivers for location, shape and scale of the price distribution." *The Energy Journal* 45.3 (2024): 107-144.
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Intraday Price Distribution is non-Gaussian with heavy tails and conditional volatility

Volatility depends the time to delivery, on market design and fundamental variables

Merit-order effect in the volatility can be modelled by taking the slope of EPEX spot market curves

Dependence between different products (delivery periods) in the continuous trading increases towards gate closure

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