



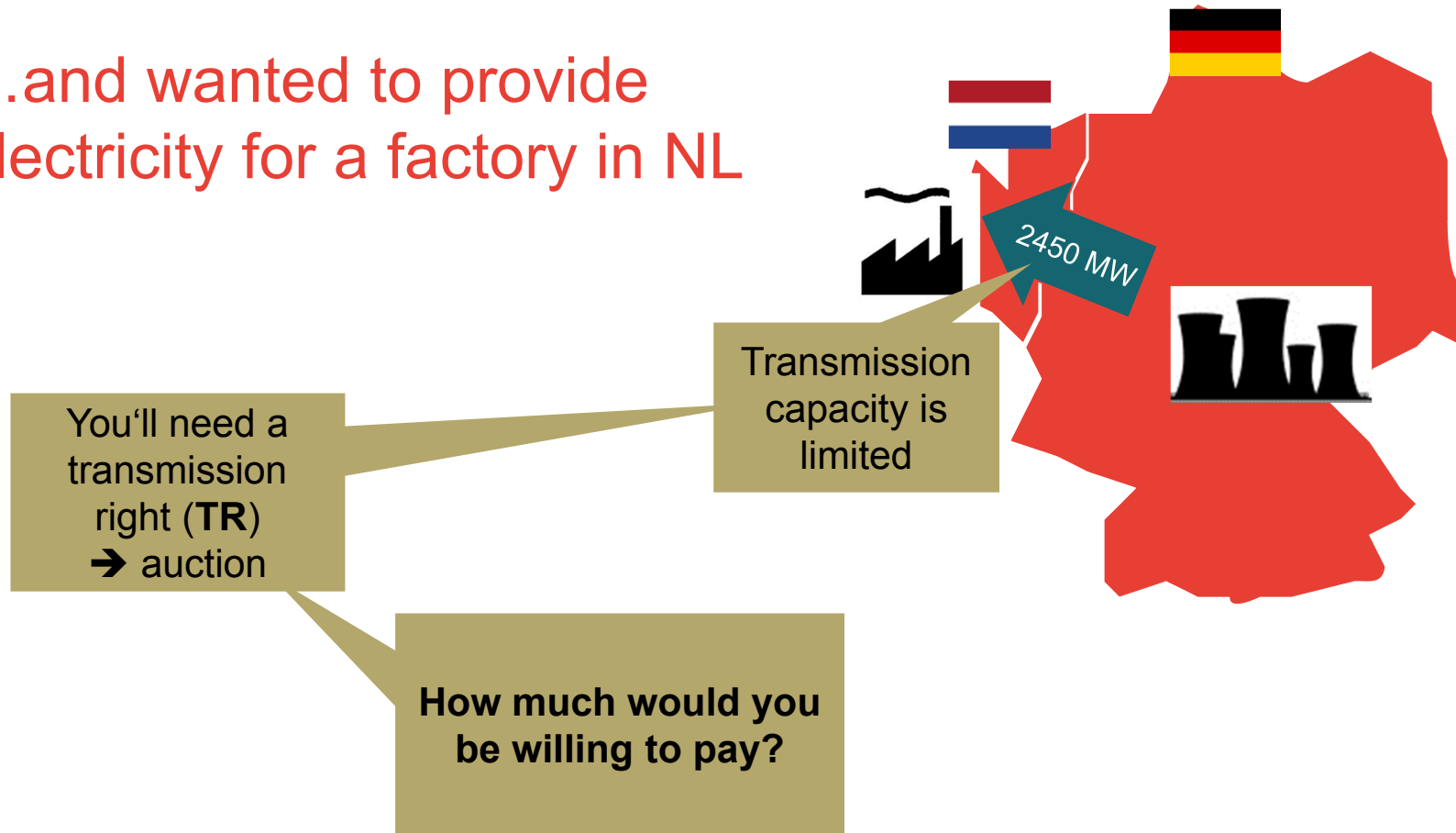
Towards a Better Design of Electricity Transmission Rights - a Monte Carlo based option valuation

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Imagine you operated a power plant in Germany...

...and wanted to provide electricity for a factory in NL



Transmission rights are options on hourly price spreads



Example

- Your power plant operates baseload → physically long
- You have a TR for the next month
- You sell a base contract to a factory in NL for next month → long position closed

In hours where $P_{NL} \geq P_{GE}$
→ **use TR**

In hours where $P_{NL} < P_{GE}$
→ **don't use TR**

- **Sell in Germany**
- **Buy in NL**

Lesson

Value of the TR = sum of cross-border spot price spreads during next month!

Problem

Spot prices in the future unknown and no traded expectations (forward products) on hourly spot prices...

A

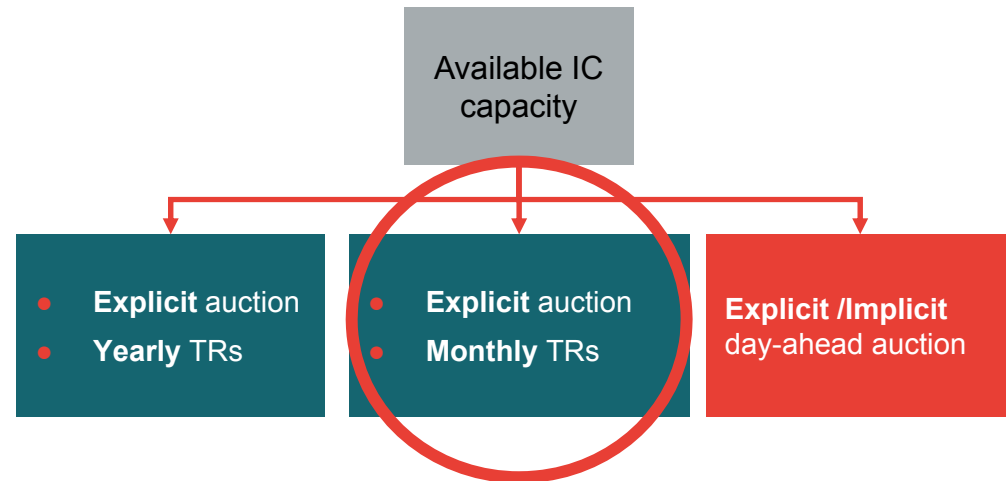
Use **historic spot price data** to simulate the spot price characteristics

B

Use all available market data that reveal **price expectations for the delivery month**

- Data
- Model
- Results
- Conclusion

Data



11 monthly PTR auctions

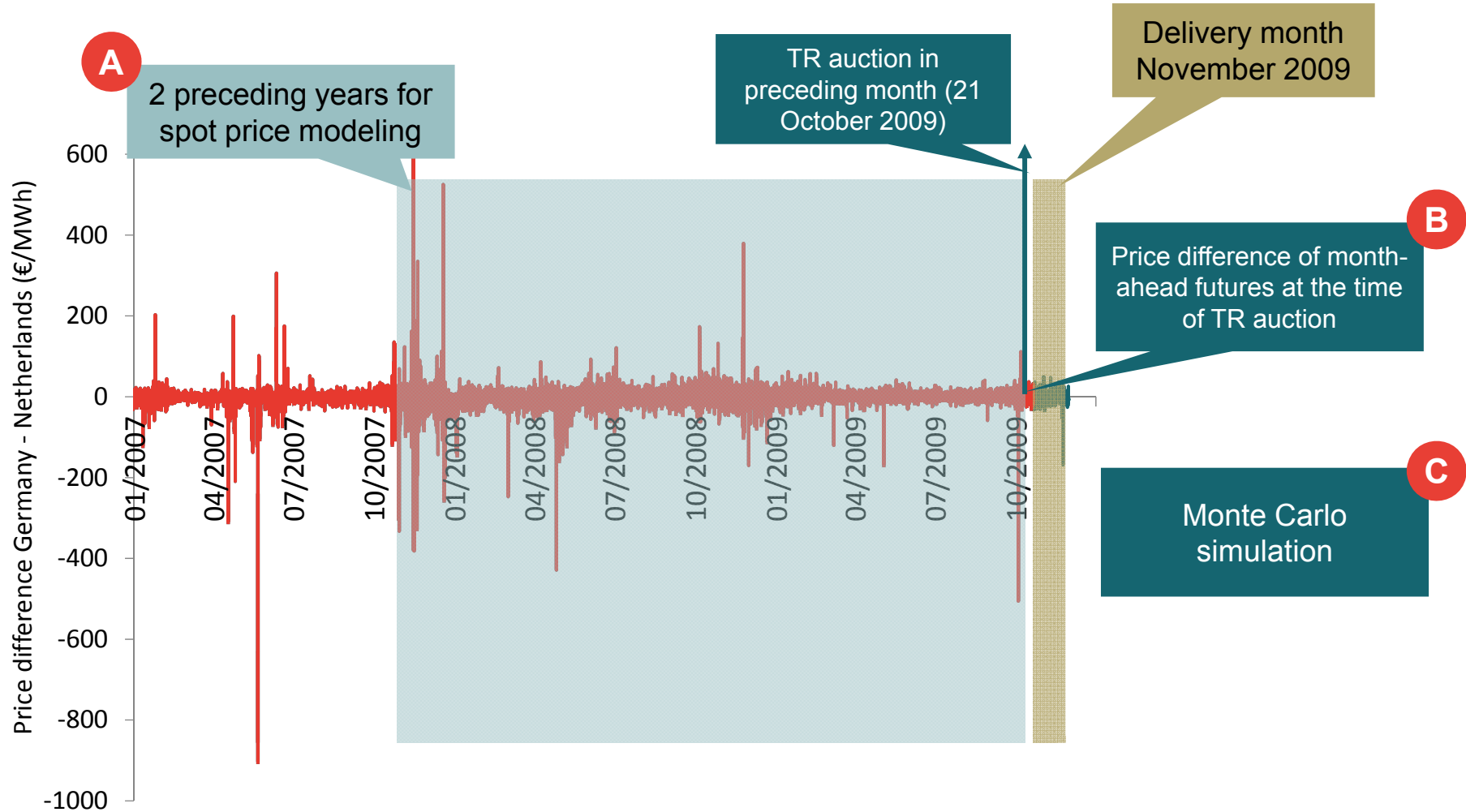
November 2009 to October 2010

Data sources: APX, EEX, Endex, Entso-E, Casc EU

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Timeline of used data

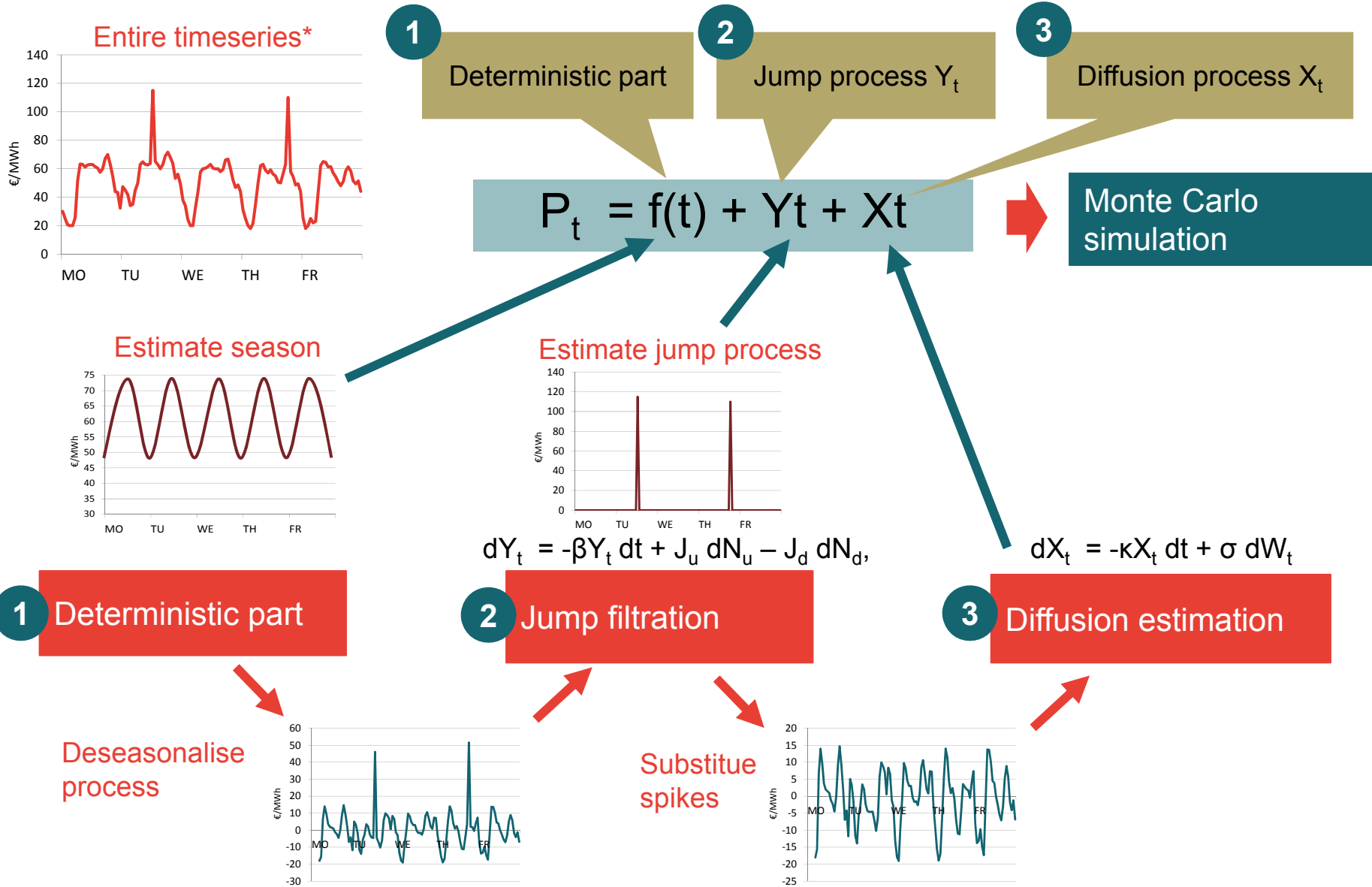
Example: Auction for November 2009 transmission right



...same procedure for all 11 monthly PTRs

A

Estimation of stochastic spot price process P_t



Estimating the deterministic component $f(t)$

Now: Cross-border spreads GE-NL

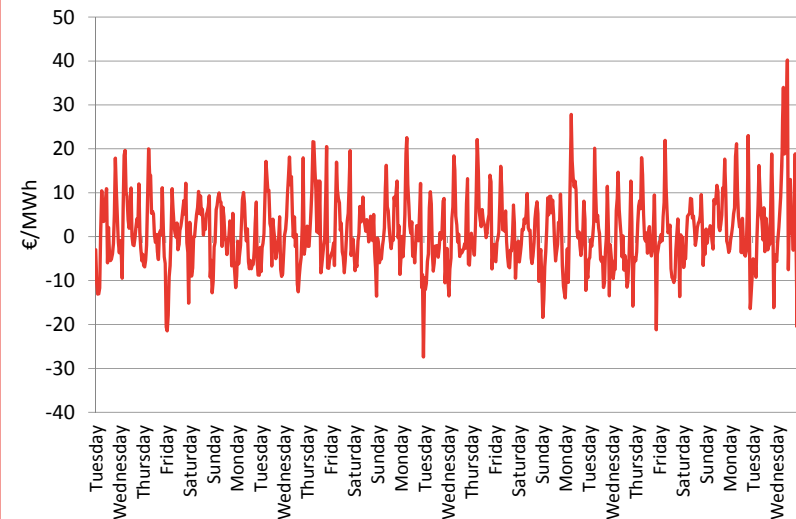
Systematic pattern in spreads?

- No overall level $\neq 0$
- No trend
- No systematic pattern (season)
 - No season of the year
 - No week/weekend pattern
 - No pattern during the day (e.g. peak/off-peak)
- Nothing that reveals information for spot price spreads during the forthcoming delivery month
- $f(t) = 0$

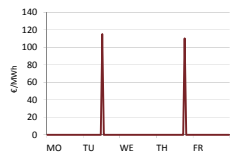
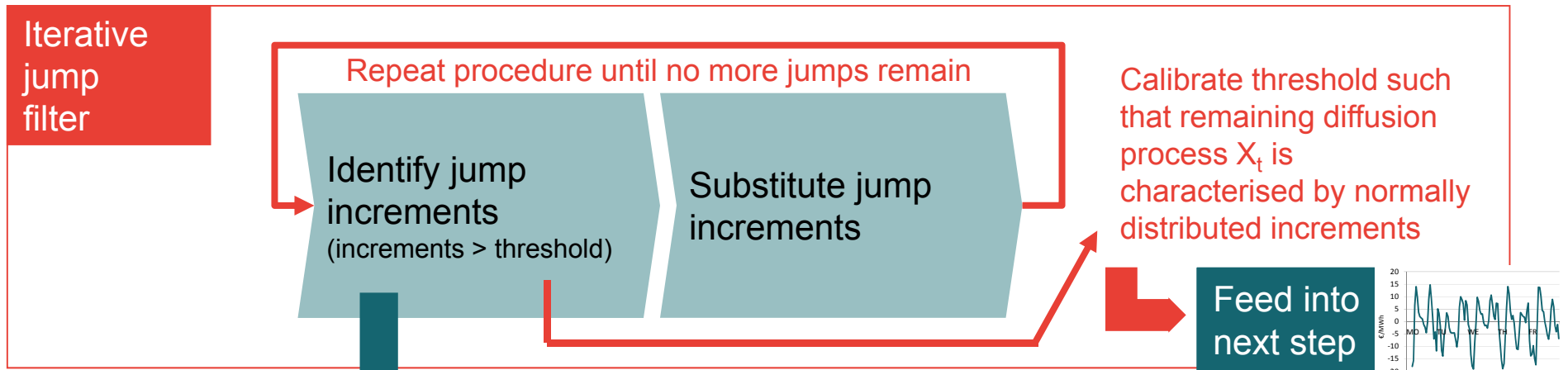


Use in MC simulation

Exemplary: Spreads GE-NL September 2009



Filtering and estimating jumps



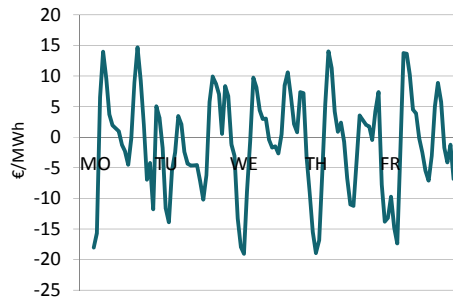
Maximum-Likelihood estimation of jump processes Y_t

- Positive jumps
- Negative jumps

Estimated parameter	
Frequency of neg. jumps	3.38%
Mean size of neg. jumps	-10.12 €/MWh
Frequency of pos. jumps	3.94%
Mean size of pos. jumps	9.38 €/MWh
Mean reversion speed β	1.03

Use in MC simulation

Estimating the residual diffusion process X_t



Increments approximately normally distributed after filtration

Maximum-Likelihood estimation

Estimated parameter	
Mean reversion speed κ of diffusion process	0.24
Volatility σ of diffusion process (€/MWh)	3.03

Use in MC simulation

Integrating information on expected price spreads

Forwards on hours

No forward products traded on hourly prices or spreads

Forwards on month

Still, spread in prices of month-ahead base forward reveal information about expected spot price spreads **on average**

Use in simulation

For every TR,

- we set the deterministic part $f(t)$ to the month-ahead base future price spread
- traded on the day of the TR auction

Example: for TR Nov 2009:

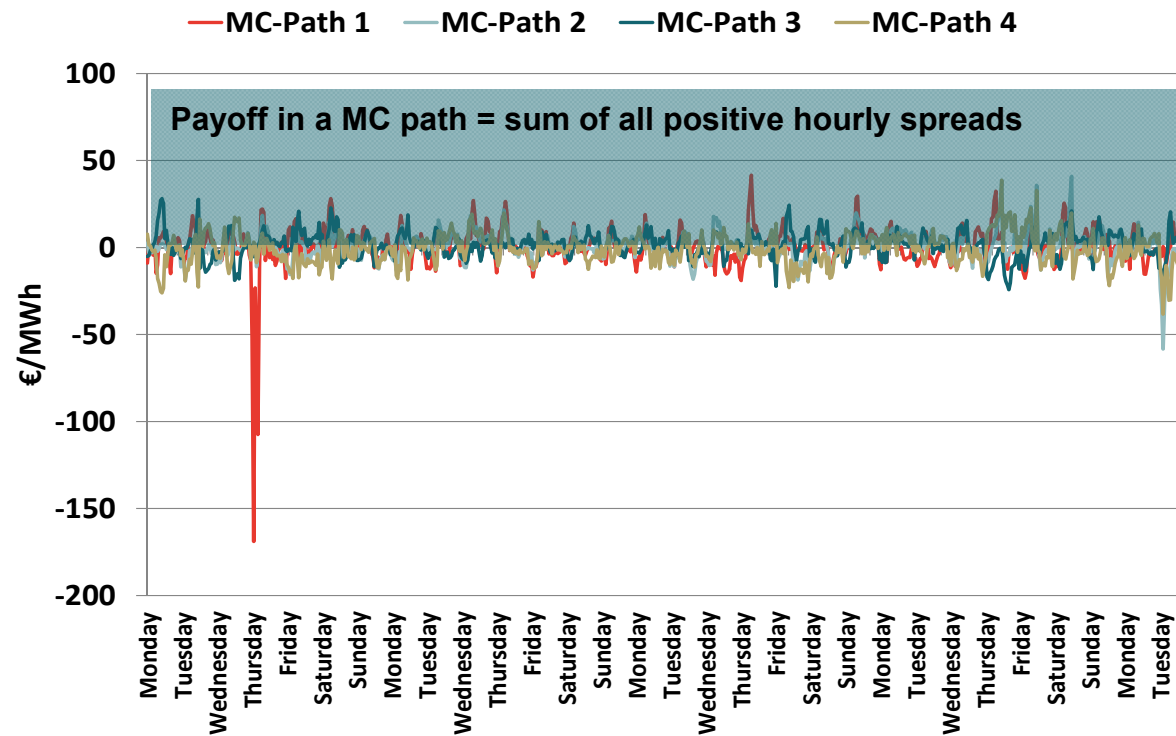
- $f(t) = 0.51 \text{ €/MWh}$
- Traded on 21 Oct 2009

C

Monte-Carlo (MC) simulation

MC simulation

Simulation of 10,000 simulation paths by generating random numbers according to the estimated parameters

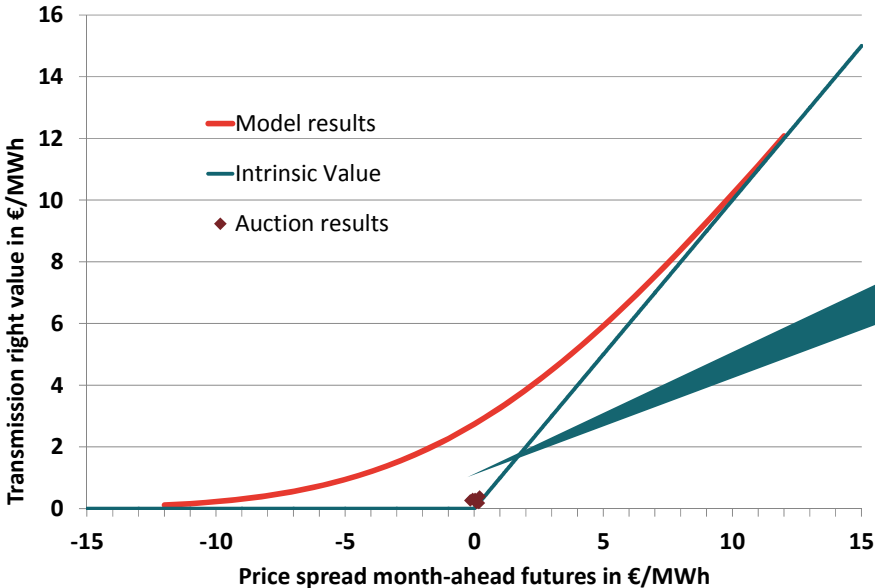


TR value

Value of transmission right = average of all 10,000 payoffs

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Modelled values > auction results



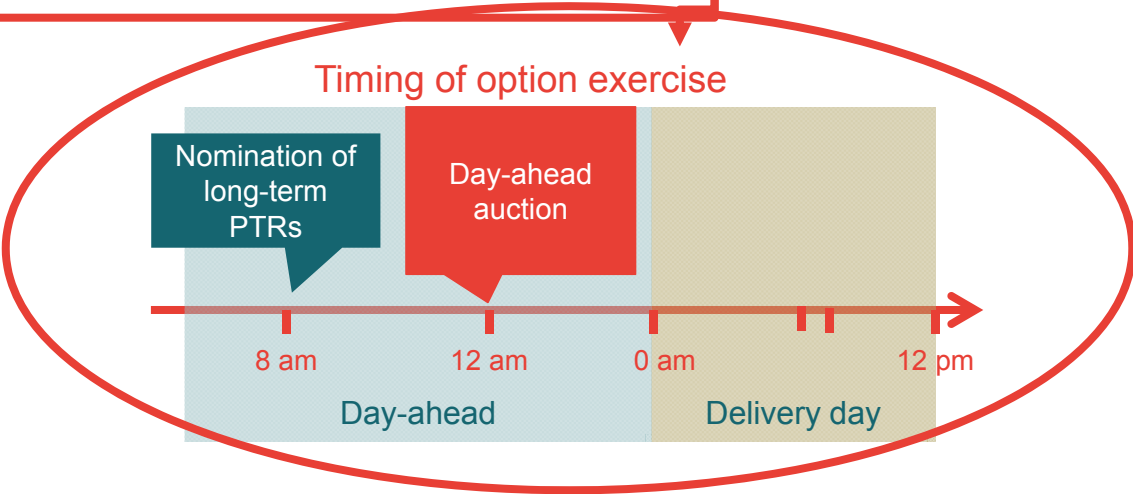
Modelled TR values exceed actual auction results by far!

Even though: Actually realisable profit (ex-post) = 3,4 €/MWh

Potential institutional reasons

Non-firmness of transmission rights

TSOs with the right to curtail transport if available transmission capacity is lower than expected



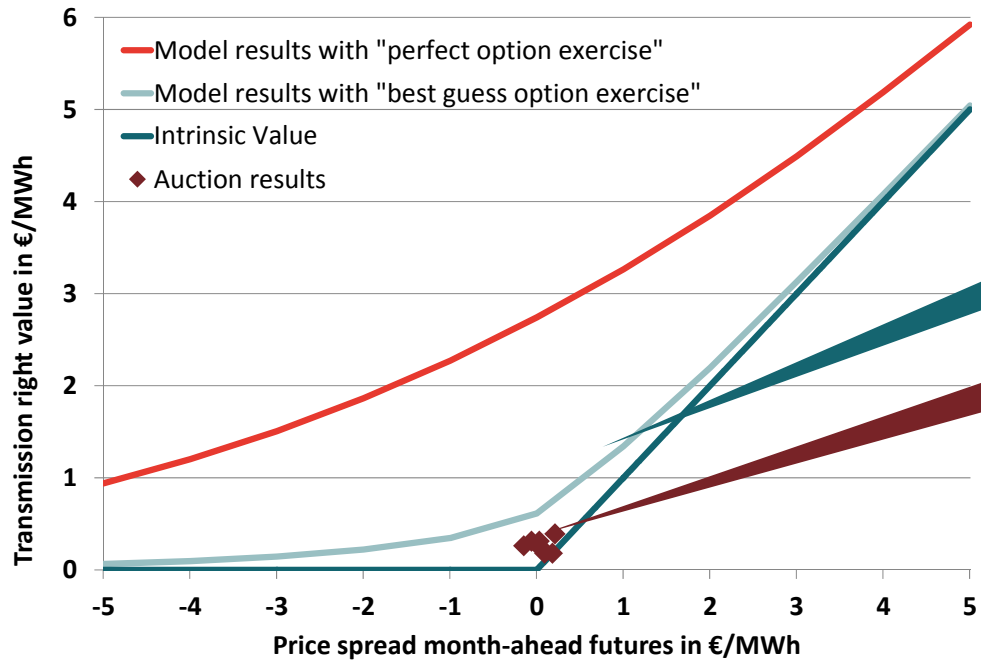
Now we take nomination uncertainty into account

Are PTRs underprice?

Assumption

No payoff in case of non-nomination
 → Physical transmission right (PTR) with UIOLI*

Current European market design



PTRs with "best guess exercise" worth much less

Actual PTRs still cheaper than modelled PTRs with "best guess exercise"

Potential reasons

Institutional reasons

- Non-firmness of PTRs

Model failures

- Constant volatility
- ...

Market preferences

- Players don't value PTRs as options → buy PTRs as they're a bargain!

* UIOLI = Use-it-or-lose-it → we assume that a potential manual resell does not reveal any payoffs.

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In short...

What did we learn?

- Valuation of hourly exercisable transmission rights is challenging, but possible
- Nomination uncertainty depresses the option value significantly
 - ➔ Use-it-or-**sell-it** or **Financial** TRs are preferable
- PTRs could well be underpriced
 - ➔ in that case there are arbitrage potentials

Further research

- Improve the model
- Analyse other borders



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