The impact of long-term seasonality on day-ahead electricity price forecasts

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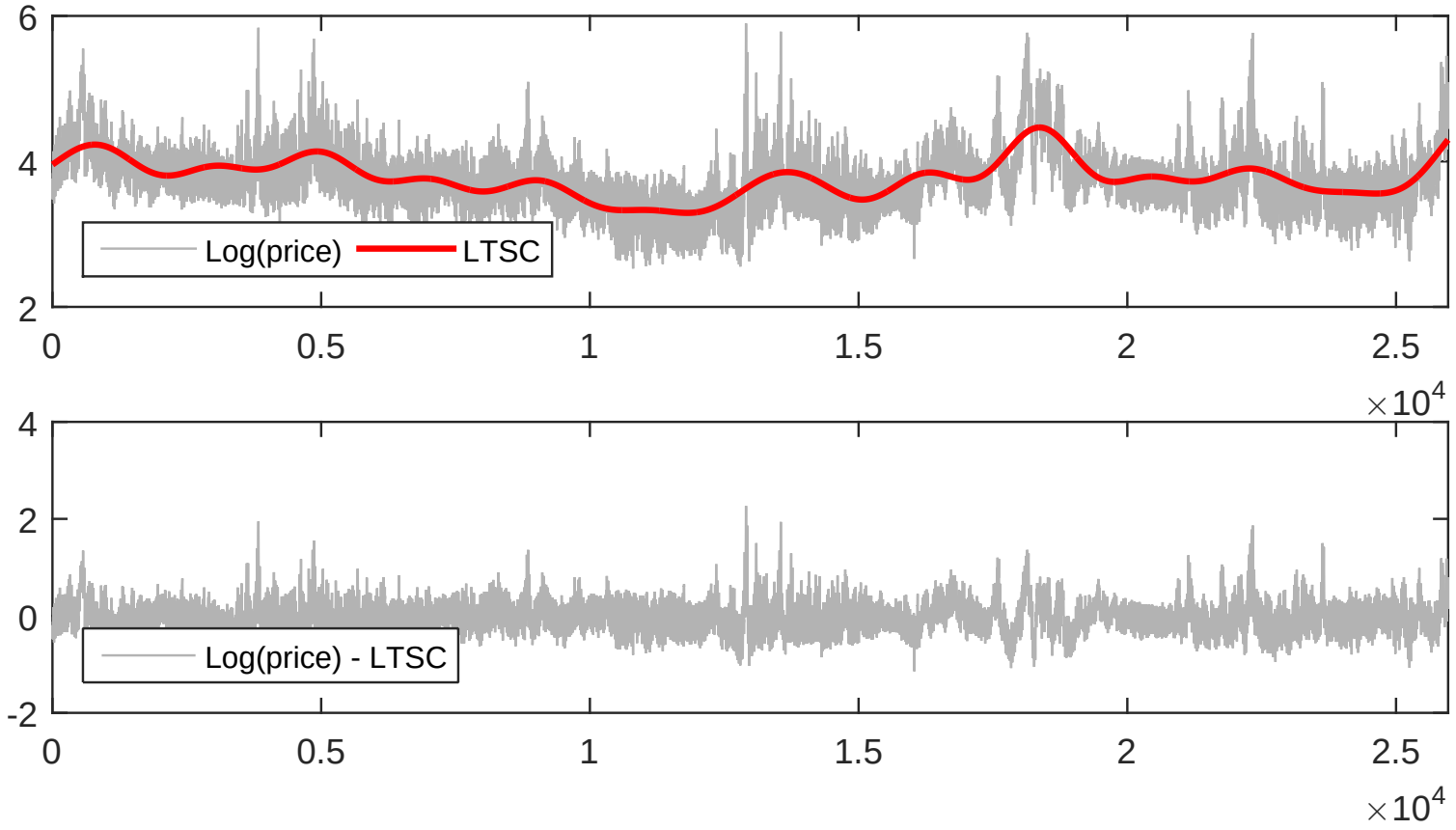
Introduction

- Can the long-term (eg. yearly) seasonal component impact short-term (day-ahead) forecasts of electricity price?



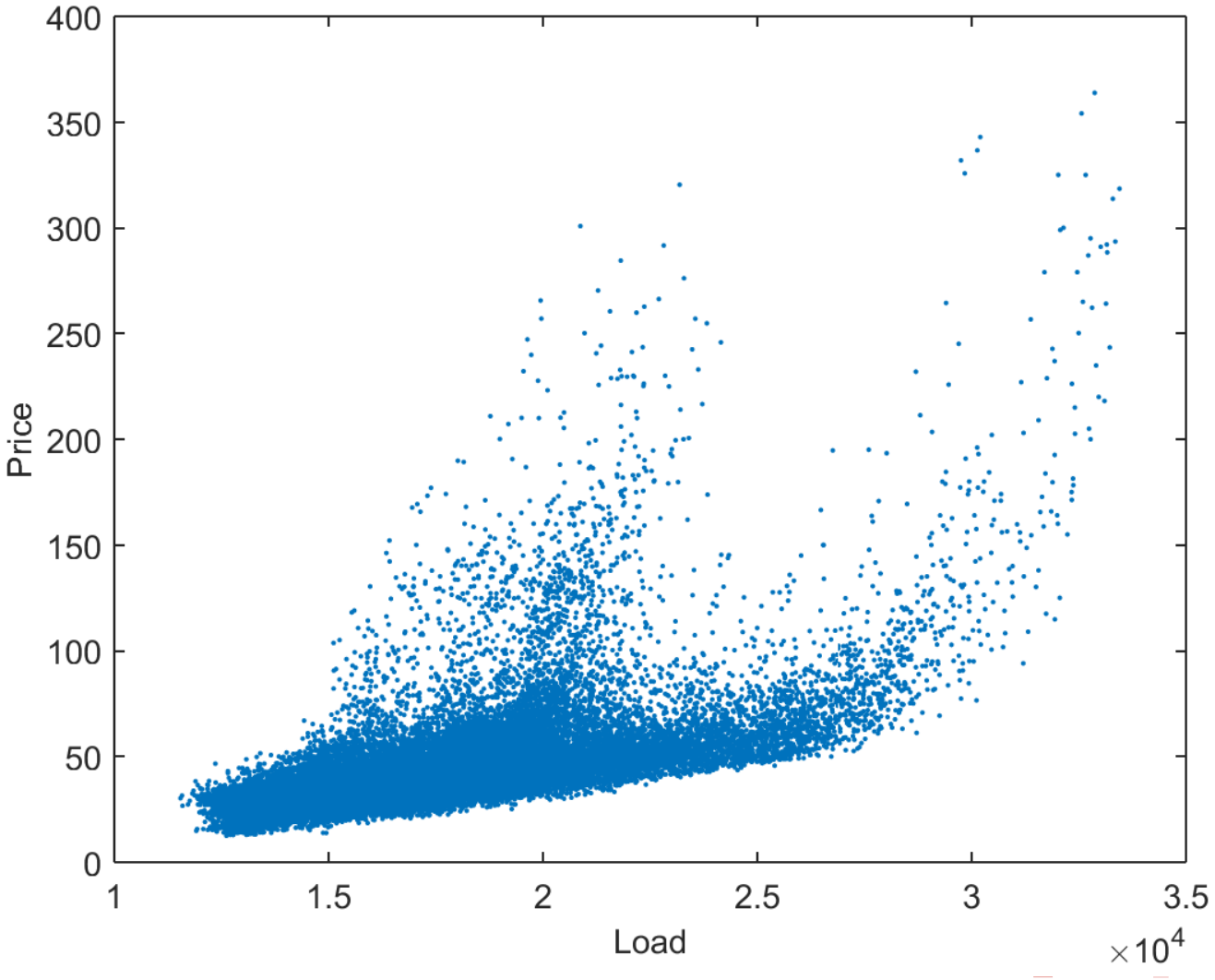
Introduction cont.

- Weron, 2014: *The overall impression is that the issue of seasonality has been downplayed in the EPF literature*
- Conejo et al., 2005; Nogales et al., 2002; Weron and Misiorek, 2008: *For short-term forecasting usually long-term trend-seasonal component is not taken into account – it adds unnecessary complexity to the already parameter-rich models*
- Nowotarski et al., 2013: *If the price series is deseasonalized, then LTSC has to be known ex-ante or predicted*

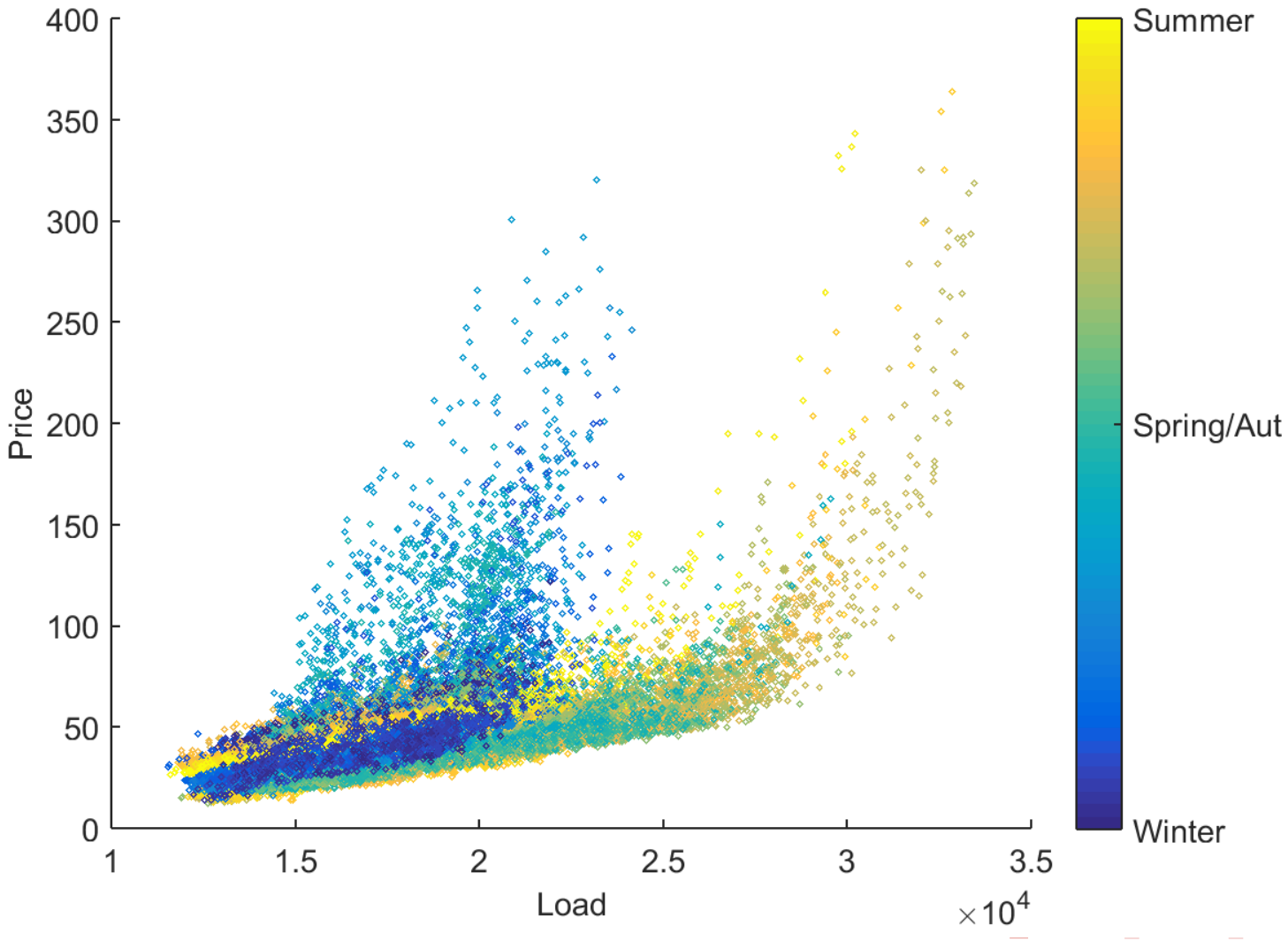
Motivation

- A partly known problem, no discussion so far
- The first step to an analisis of probabilistic forecasts
- An appealing way to apply forecast combination
- The real LTSC is unobserved
- Forecasting decomposed price cannot be properly evaluated

Electricity price – load relationship



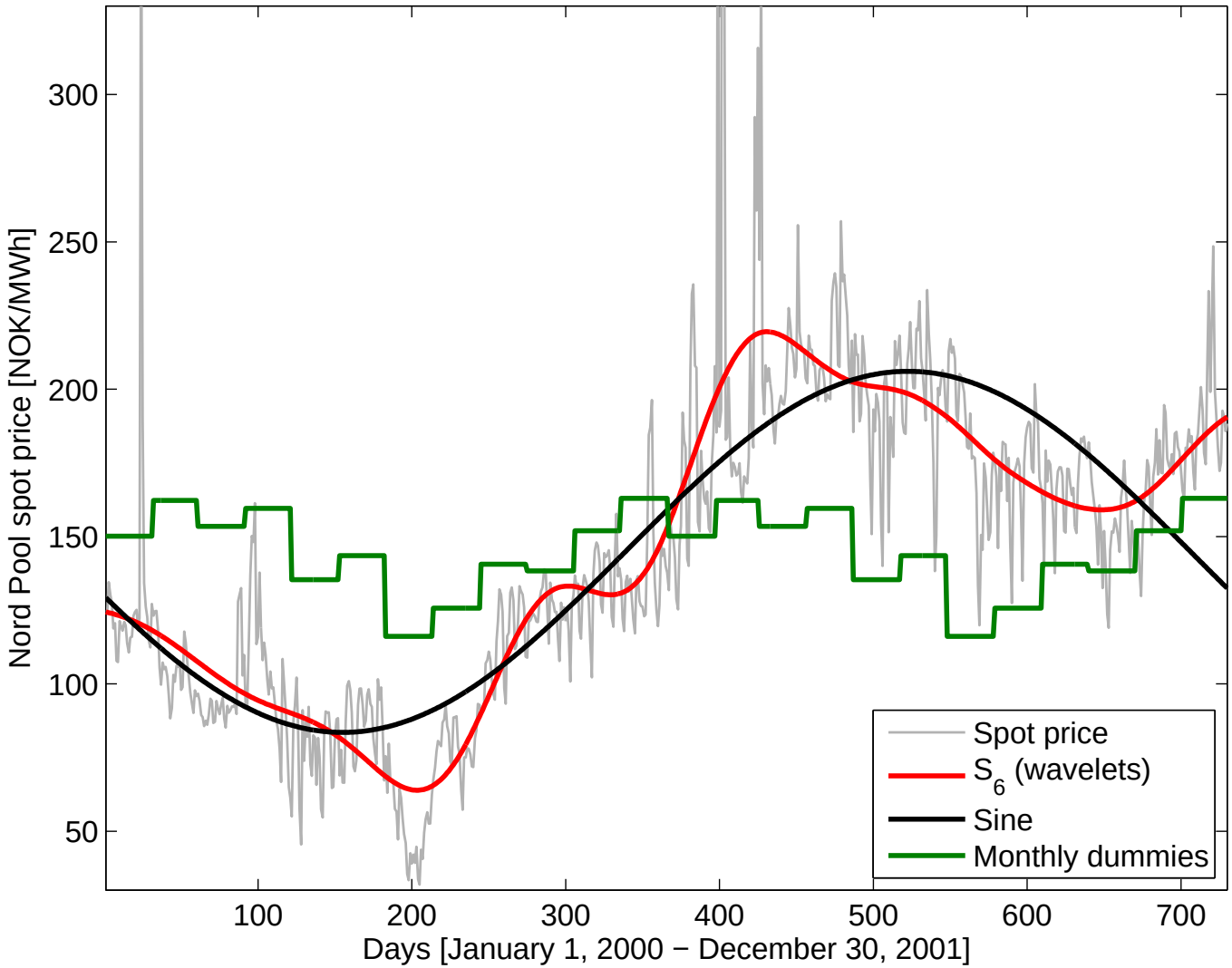
Electricity price – load relationship cont.



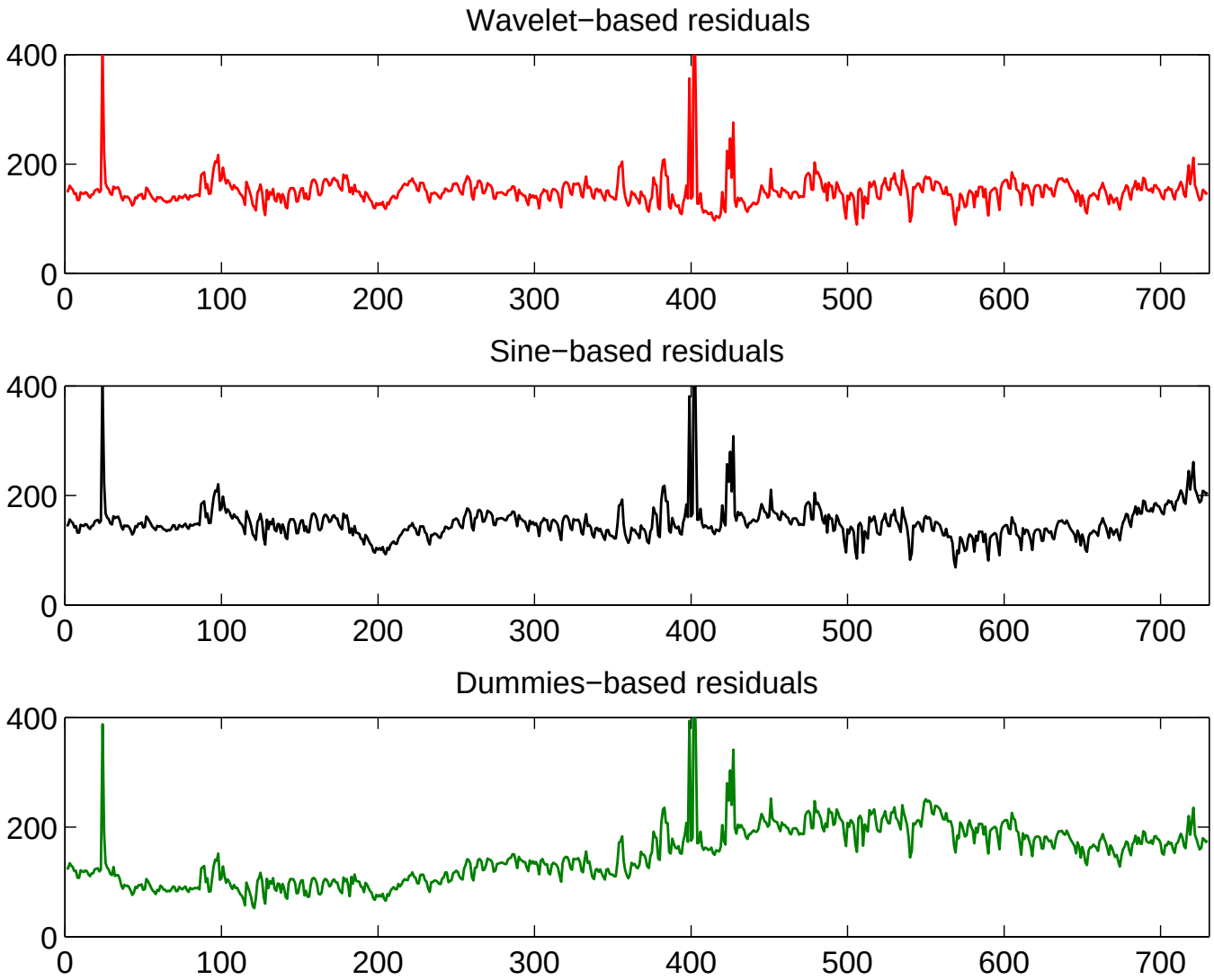
Modeling the trend-seasonal components

- Standard approach – decompose a time series of prices P_t into
  - the long-term trend-seasonal component (LTSC) L_t
  - the short-term seasonal component (STSC) s_t
  - and the remaining variability, error or stochastic component X_t
- The hourly/weekly STSC is usually captured by autoregression & dummies $\longrightarrow$ forecasting is straightforward
- Annual seasonality is present in spot prices, but in most cases the LTSC is dominated by a more irregular cyclic component
  - Due to fuel prices, economic growth, long-term weather trends
  - See e.g. Janczura et al. (2013), Nowotarski et al. (2013)

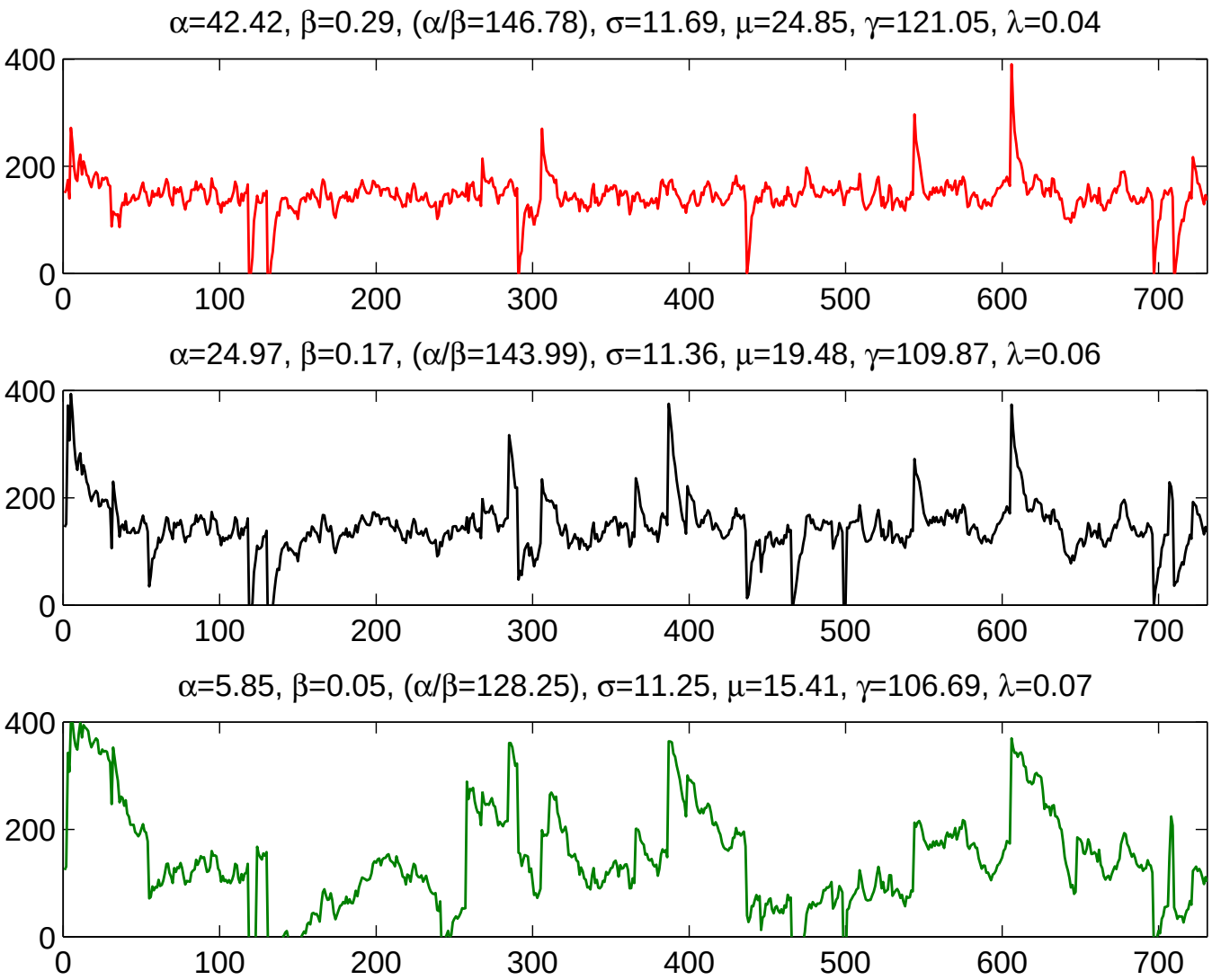
3 LTSC fits to Nord Pool spot prices



3 stochastic components (residuals)



3 MRJD fits: $dX = (\alpha - \beta X)dt + \sigma dB + \mathcal{N}(\mu, \gamma)dN(\lambda)$

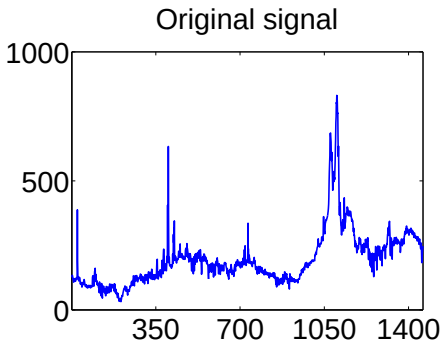


3 MRJD fits: conclusions

- The 3 different seasonality functions lead to different conclusions
- The residual processes vary
- Estimatated parameters of MRJD models are not similar
- Simulated process (for the estimated parameters) are very far from each other
- As a consequence the forecasts may vary as well
- Nowotarski, Tomczyk, Weron, 2013: use wavelets

Wavelets

Decomposition of a signal



Wavelets

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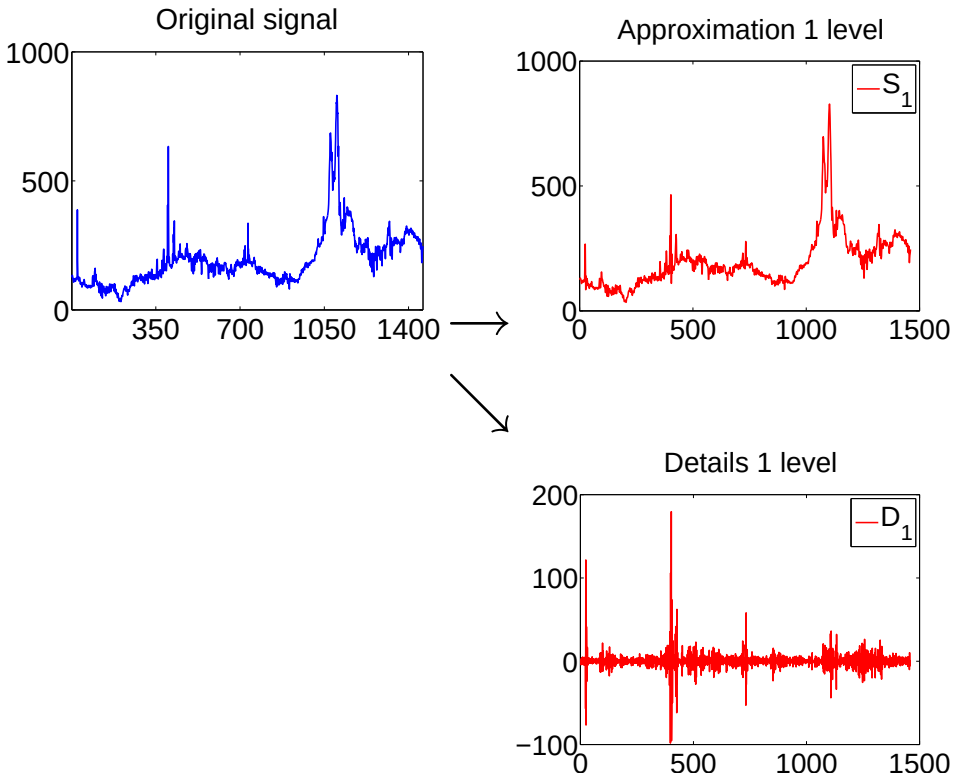

Wavelets

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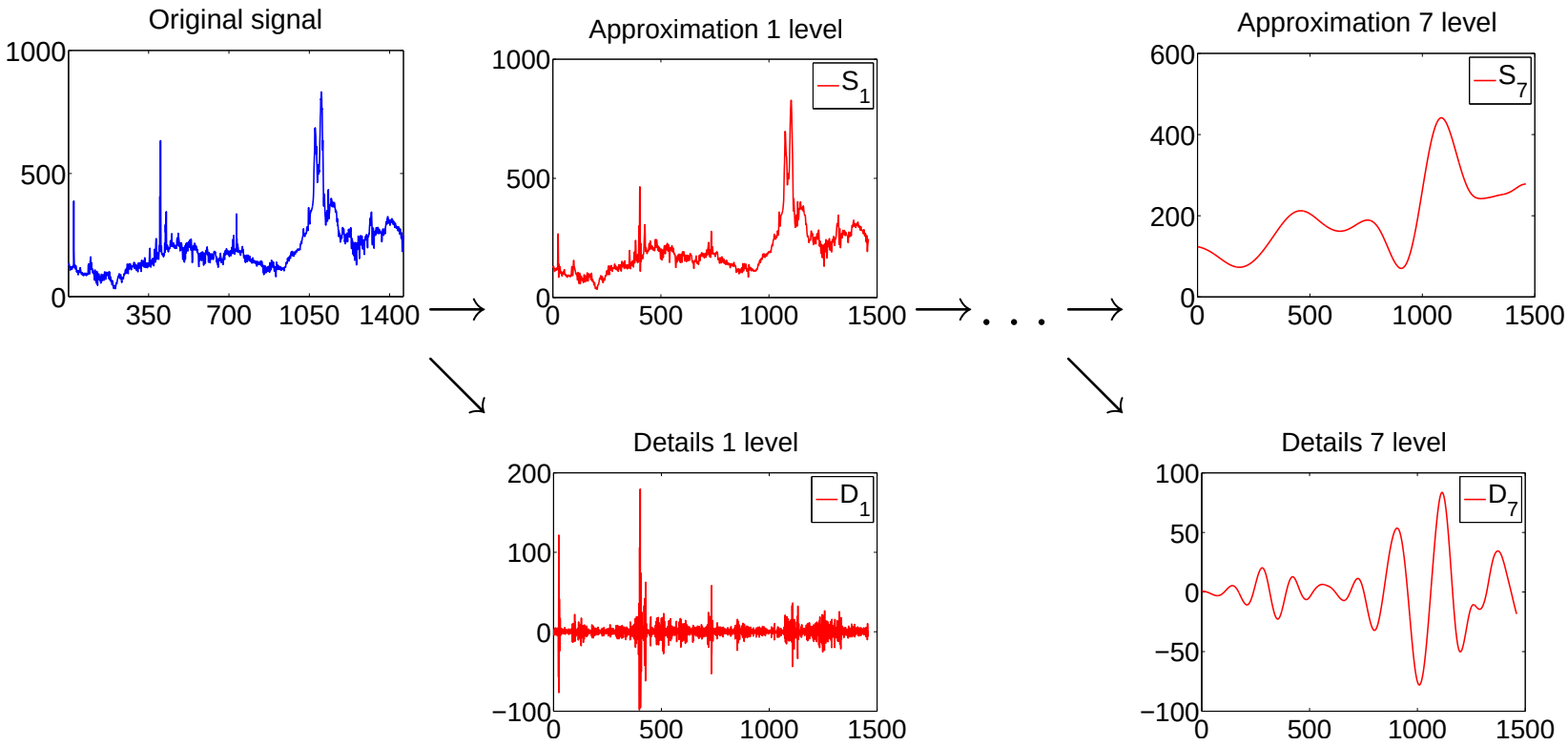


Agenda

- Introduction
- Modeling long-term seasonality
- **Case study**
  - The design of the case study
  - Approach 1: LTSC known ex-ante
  - Approach 2: LTSC predicted in a naive way
- Summary

Case study

- Spot price decomposition: $P_t = L_t + X_t$
- Residuals X_t modeled with ARX
- Seasonality L_t: either known ex-ante ($\widehat{L}_{t+h|t} = L_{t+h}$) or a naive day-ahead prediction ($\widehat{L}_{t+h|t} = L_t$)
  1. $\widehat{P}_{t+h|t} = \widehat{L}_{t+h|t} + \widehat{X}_{t+h|t} = L_{t+h} + \widehat{X}^{ARX}_{t+h|t}$
  2. $\widehat{P}_{t+h|t} = \widehat{L}_{t+h|t} + \widehat{X}_{t+h|t} = L_t + \widehat{X}^{ARX}_{t+h|t}$

Case study: the benchmark

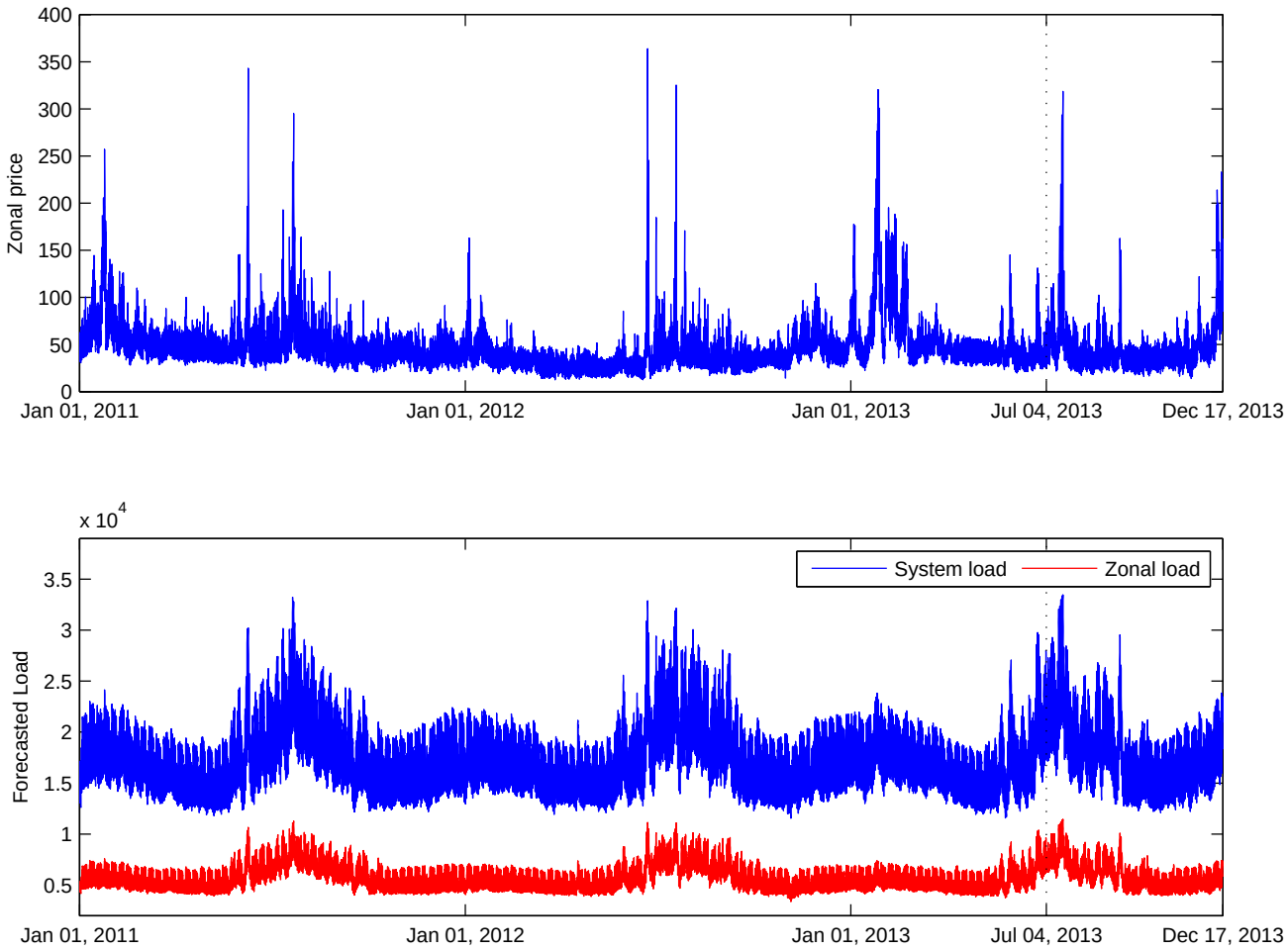
- The benchmark: same ARX model without deseasonalization
- Does long-term seasonality have an impact on short-term forecasting?
- ARX specification (Weron, Misiorek, 2008):

$$\begin{aligned} p_t &= \phi_1 p_{t-24} + \phi_2 p_{t-48} + \phi_3 p_{t-168} + \phi_4 mp_t + \\ &+ \psi_1 z_t + d_1 D_{Mon} + d_2 D_{Sat} + d_3 D_{Sun} + \varepsilon_t, \end{aligned}$$

  - p_t is the log-price
  - mp_t is the minimum of the previous day's 24 hourly log-prices
  - D_{Mon}, D_{Sat} and D_{Sun} are weekday dummies
  - z_t is electricity load

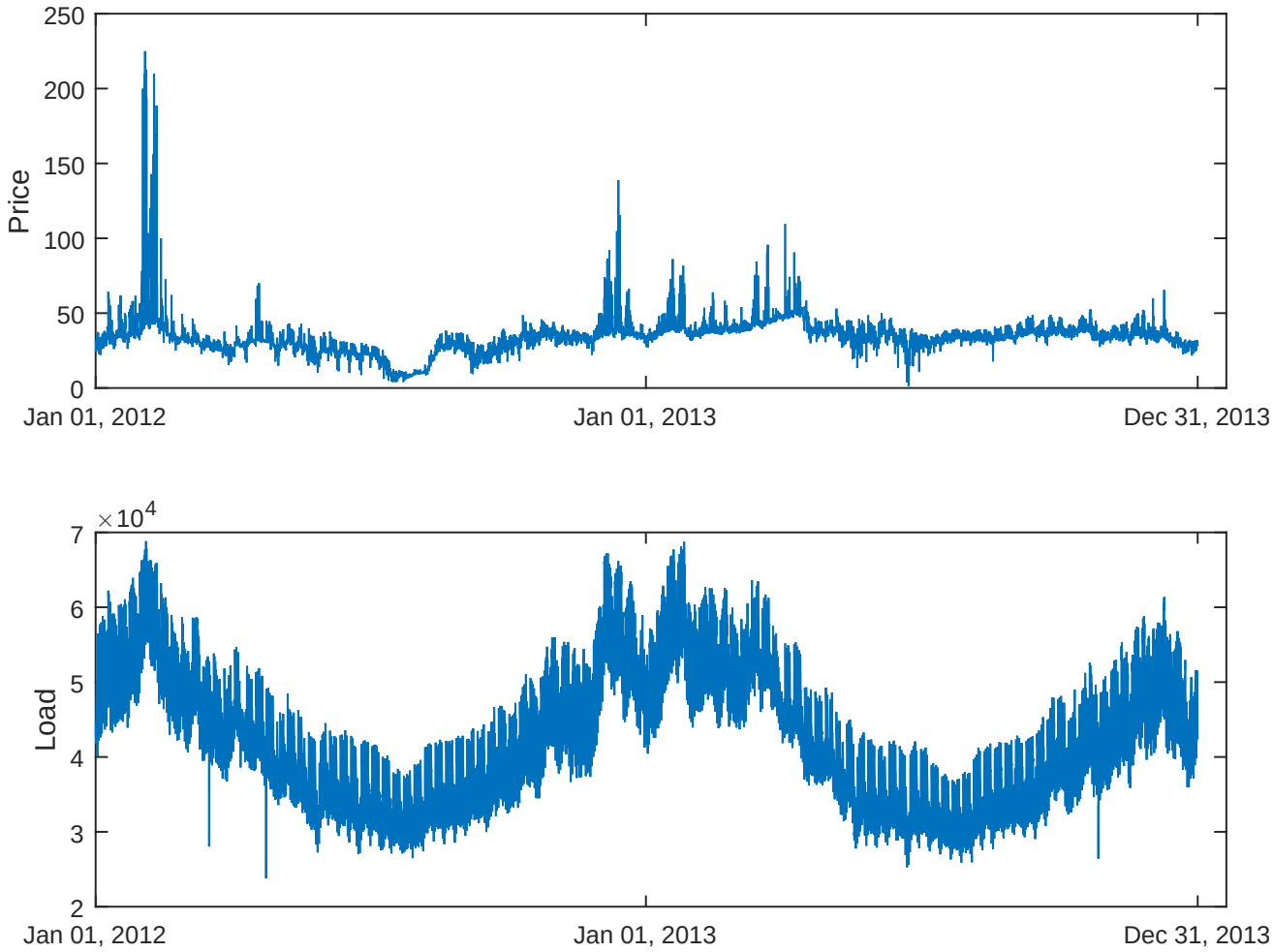
Case study: the data

GEFCom2014



Case study: the data

Nord Pool 2012-2013



Case study: design summary

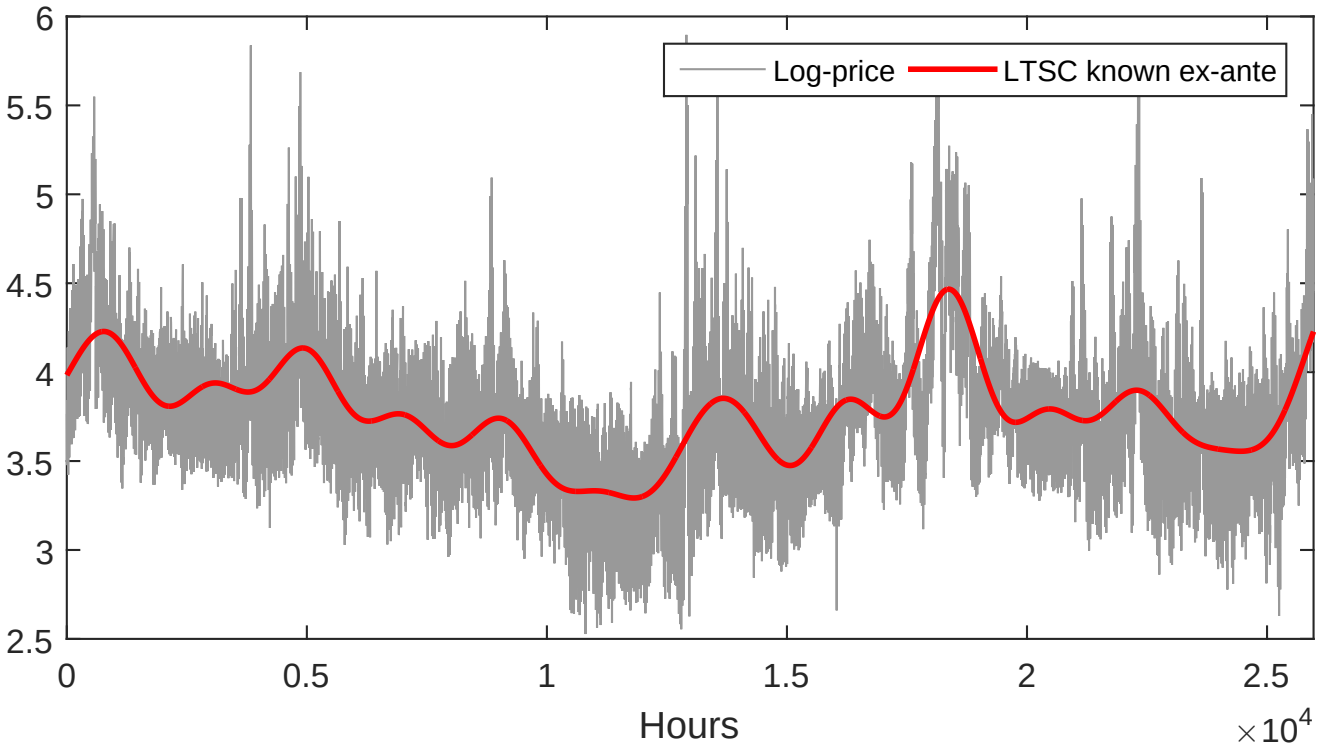
- 2 datasets, 30 weeks for the evaluation of forecasts
- The benchmark: ARX model without removing LTSC
- LTSC known ex-ante or predicted
- Evaluatoin made with weighted/weekly MAE, averaged over 30 weeks:

$$\mathrm{WMAE}_i = \frac{1}{\bar{P}_{168}}\mathrm{MAE}_i = \frac{1}{168 \cdot \bar{P}_{168}} \sum_{h=1}^{168} \left| P_h - \hat{P}_{ih} \right|$$

Case study: step 1

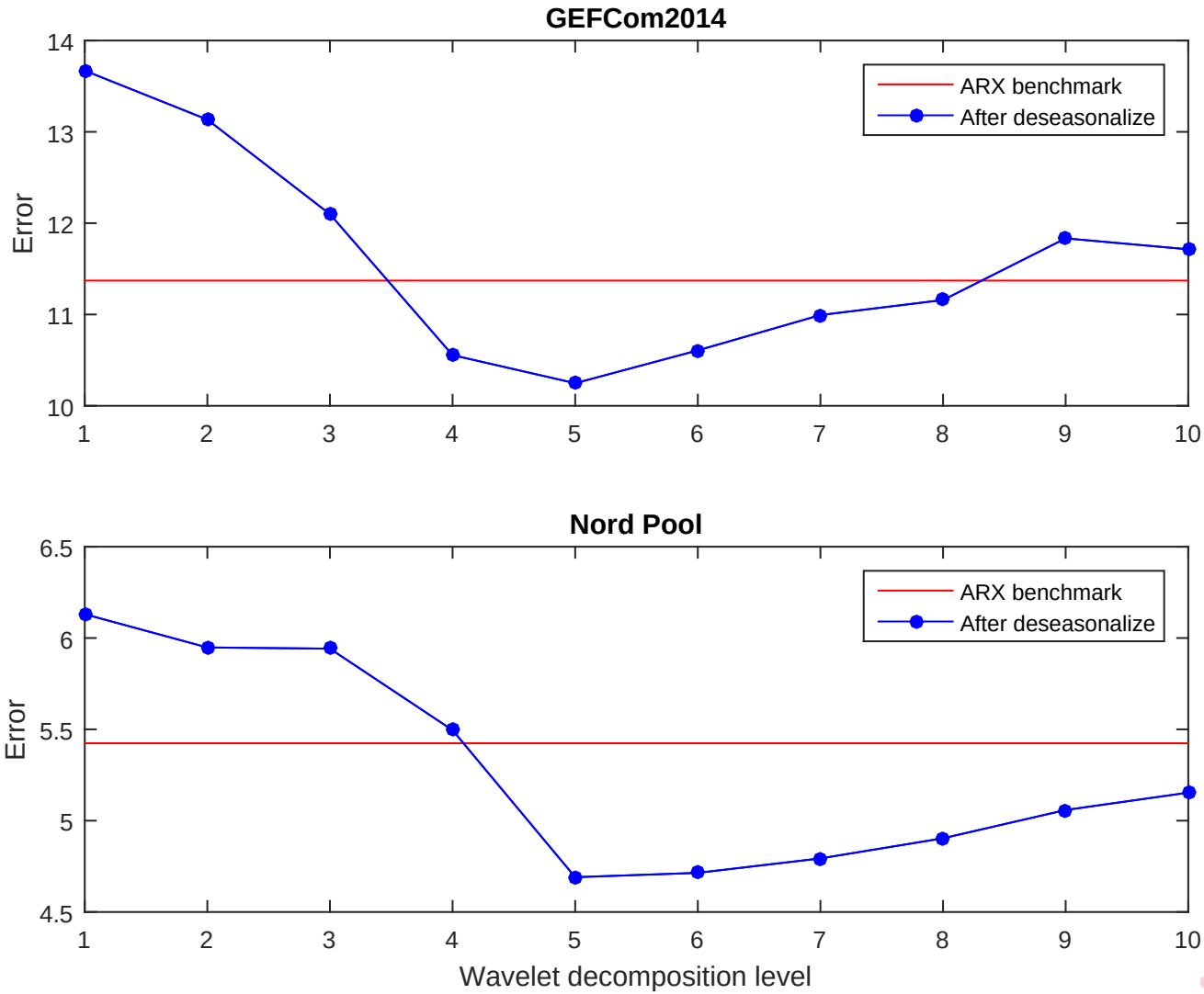
LTSC known ex-ante

- Deseasonalize the data once, the future LTSC is known
- Forecast only X_t



Case study: step 1

LTSC known ex-ante: results



Case study: step 1

LTSC known ex-ante: conclusions

- For most 'reasonable' wavelets levels removing LTSC improves forecasting accuracy
- For Nord Pool the result is better than for GEFCom
- However...

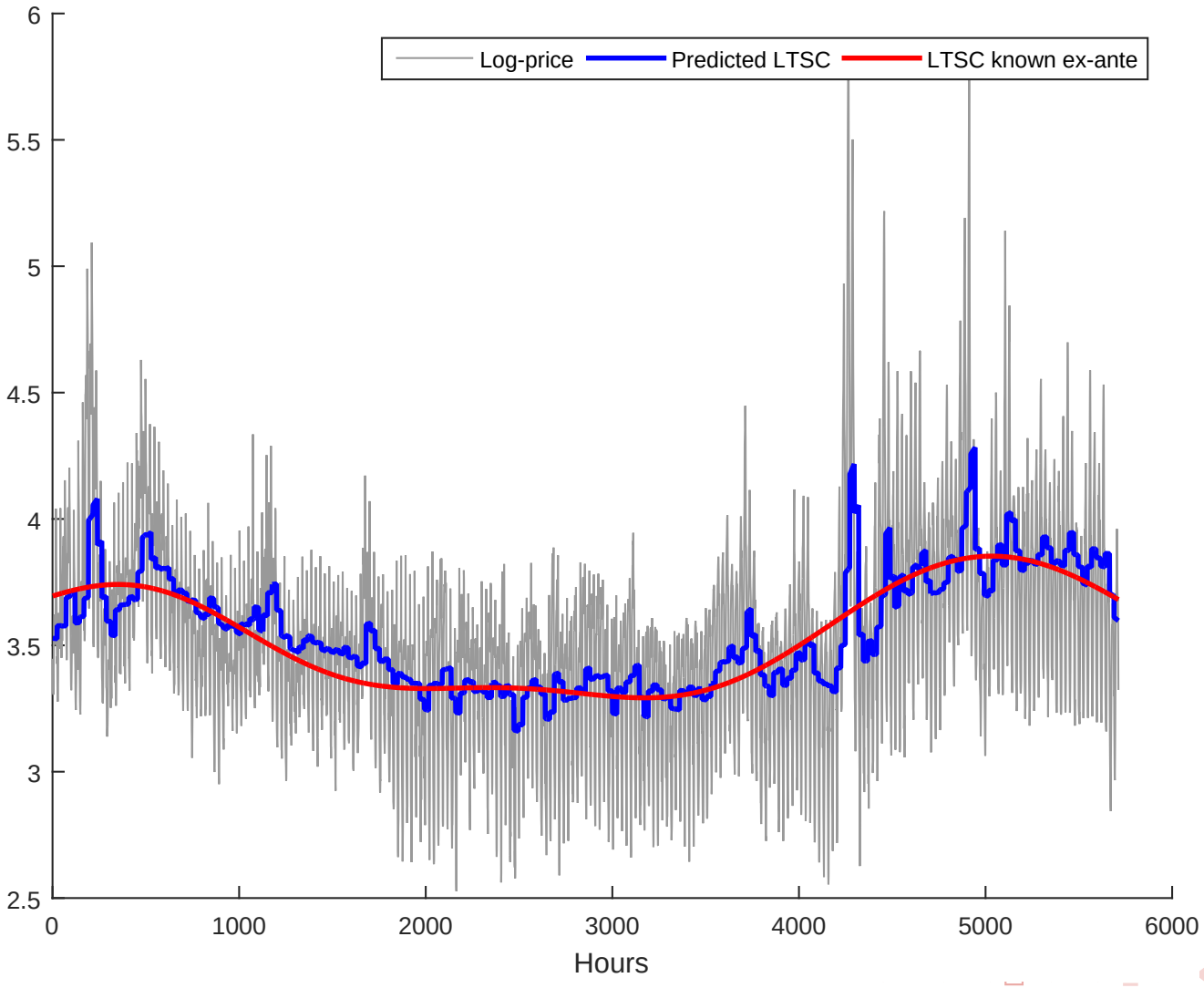
Case study: step 1

LTSC known ex-ante: conclusions

- For most 'reasonable' wavelets levels removing LTSC improves forecasting accuracy
- For Nord Pool the result is better than for GEFCom
- However...
  - The 'true' LTSC was known in advance
  - How to forecast it?
  - How to decide whether this forecast is good or not?
  - How to decide whether the prediction of X_t is good or not?

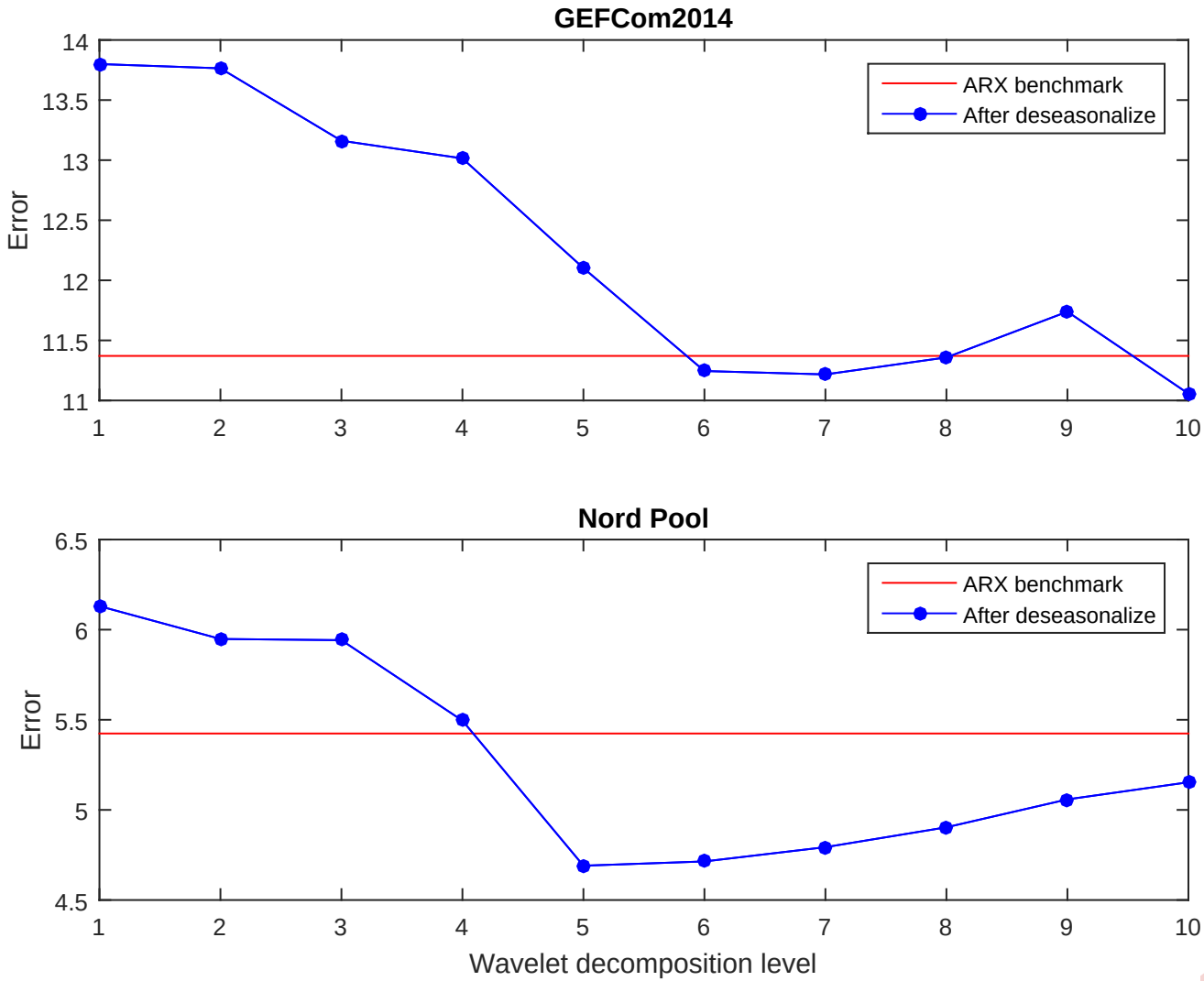
Case study: step 2

LTSC predicted each day



Case study: step 2

LTSC predicted each day: results



Case study: step 2

LTSC predicted each day: conclusions

- Still, removing LTSC and predicting it in a naive way results in not worse forecasts
- For Nord Pool the result is better than for GEFCom (again), but GEFCom is not satisfactory
- However...

Case study: step 2

LTSC predicted each day: conclusions

- Still, removing LTSC and predicting it in a naive way results in not worse forecasts
- For Nord Pool the result is better than for GEFCom (again), but GEFCom is not satisfactory
- However...
  - The way to forecast LTSC was naive
  - A deeper investigation of residuals' process may reveal new insights
  - The forecast with LTSC predicted each day pass Diebold-Mariano test for 18 of 24 hours

Summary

- A new approach of short-term electricity price forecasting
- A way to bridge the gap (*"the issue of seasonality has been downplayed in the EPF literature"*)
- Some open questions remain:
  - How to evaluate the decomposed forecasts?
  - Is there a way to predict LTSC better than with a naive forecast?
  - What may cause the differences between datasets?

Comments, questions?

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