PhD in Economics and Management

Optional Course on
ECONOMIC AND QUANTITATIVE ANALYSIS OF ENERGY MARKETS
(15 hours)

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Purpose of the course
Energy Markets analysis could be carried out from different perspectives. The main idea behind this course would be to focus on the economics of energy markets and on related quantitative models based on linear and nonlinear processes for measuring and forecasting volumes and prices. The focus of the course will be on electricity markets, although reference will also be made to natural gas markets.
Some recent developments about the introduction of renewable sources on the electricity grid and to the economic feasibility of electricity storage will conclude the course.
The main goal of the course will be to illustrate methods and approaches with detailed examples using real data and to provide PhD students with a set of economic models and econometric-statistical tools to perform reliable and original analyses.

Prerequisites
PhD students should be familiar with basic notions of time series analysis and stochastic processes in discrete time and with elementary notions of industrial economics.
Basic knowledge from statistics and econometrics plus rudimentary experiences with data and numerical calculations will be helpful. Quantitative analysis will be performed by the freeware software R (http://cran.r-project.org/).

For the statistical and econometric analysis of time series we recommend:
Hamilton J.D. (1994), "Time Series Analysis", Princeton University Press.

For the economic analysis of electricity markets
Cretì, A. and Fontini, F. (2019). Economics of Electricity: Markets, Competition and Rules. Cambridge University Press.

As main reference book for the course:
Weron R., (2006), "Modeling and Forecasting Electricity Loads and Prices: A Statistical Approach", Wiley.

Table of Content

1. **Stylized facts of electricity prices**
   Price spikes: what determines spikes. Case studies.
   Seasonality: determinants. Autocorrelation structure and frequency domain analysis.
   Seasonal decomposition: moving average technique, spectral decomposition, rolling volatility technique.
   Mean reversion: detrended fluctuation analysis, periodogram regression
   Volatility clustering and leverage effect

2. **Modelling electricity loads and prices**
   Factors affecting load patterns (demand side): time factors and weathers conditions. Analysis of weather variables.

Factors affecting prices (supply side): generation factors. The impact of renewables electricity sources.
ARIMA-type models
Regression models with exogenous regressors
GARCH models
Switching models

3. **Forecasting and evaluation of forecasting performances**
   Forecasting loads and prices: selection of the best model
   Assessing forecasting performances of alternative models: MAPE, MPE, Theil's index, Diebold and Mariano test.
   The rolling windows technique
   Case studies

4. **Further topics**
   Energy storage: the case of gas and electricity
   Robust methods for energy prices and loads: implications on forecasting performances