Barcelona School of Economics

COURSE SYLLABUS | 22N002

Empirical Methods for the Analysis of the Energy Transition

3 ECTS | TERM 2 | MANDATORY

Professor

Prof. Mar Reguant

Overview and objectives

The objective of this course is to introduce the participants to key challenges in the energy sector as we decarbonize our economies. The class will be centered on quantitative tools that can assist us in modeling the rapid transformation of the energy sector, with the main focus on electricity markets.

We will show how econometric techniques can be used to assess the impacts of the energy transition on the operation of electricity markets. We will cover tools of mixed-integer programming and machine learning that can assist the quantitative modeling of these complex systems. Each block will go over a particular technique and contain a practical application with data and coding exercises.

Coding exercises will be done in Julia and Pluto notebooks (similar to Jupyter notebooks).

Prerequisites

Foundations of Data Science

Course outline

0. Introduction to quantitative analysis in electricity markets
    - Overview of the course and themes
    - Introduction to coding with Julia and Pluto

1. Overview: trends and impacts
    - Examining data on electricity markets
    - Regression analysis of high-frequency data
    - Regression discontinuity analysis and event studies

2. Supply-side: Building economic models of electricity markets
    - Optimization subject to constraints
    - Mathematical programming tools in Julia
    - Dimensionality reduction for computational tractability
    - Short- vs. long-run

3. Supply-side: Machine learning techniques
    - Incorporating climate and leakage policies to supply side
    - Incorporating transmission constraints

4. Demand-side: Electricity consumption trends and policy evaluation
    - Sectors: industrial, commercial, residential
    - Countries: developing vs. industrialized
    - High-frequency modeling: smart meters

5. Demand-side: Expanding the demand side in electricity models
    - Sectoral responses to the energy transition
    - Equilibrium retail pricing
    - Pricing and competition
    - Equity concerns regarding the transition

Required activities

Class Attendance and submission of homework and projects.

Evaluation

There will be several assignments during the course that will result in a grade.

- 30% - In-class projects to be submitted at the end of a practical session (individual).

- 70% - Home projects in groups of 2. Students will be given 2 weeks to submit their home projects.

Materials (sample)

Borenstein, S. (2012). The Redistributional Impact of Nonlinear Electricity Pricing. American Economic Journal: Economic Policy, 4(3), 56–90.

Bushnell, J., Mansur, E., & Saravia, C. (2008). Vertical Arrangements, Market Structure, and Competition: An Analysis of Restructured US Electricity Markets. American Economic Review, 98(1), 237–266.

Burlig, F., Knittel, C., Rapson, D., Reguant, M., & Wolfram, C. (2020). Machine Learning from Schools about Energy Efficiency. Journal of the Association of Environmental and Resource Economists, 7(6), 1181–1217.

Cullen, J. (2013). Measuring the environmental benefits of wind-generated electricity. American Economic Journal: Economic Policy, 5(4), 107–133.

Fabra, N., & Reguant, M. (2014). Pass-through of emissions costs in electricity markets. American Economic Review, 104(9).

Jessoe, K., & Rapson, D. (2015). Commercial and Industrial Demand Response Under Mandatory Time-of-Use Electricity Pricing. Journal of Industrial Economics, 63(3), 397–421.

Joskow, P. L. (2019). Challenges for wholesale electricity markets with intermittent renewable generation at scale: the US experience. Oxford Review of Economic Policy, 35(2), 291–331.

Kellogg, R., & Reguant, M. (2021). Energy and Environmental Markets, Industrial Organization, and Regulation.

Reguant, M. (2019). The Efficiency and Sectoral Distributional Impacts of Large-Scale Renewable Energy Policies. Journal of the Association of Environmental and Resource Economists, 6(S1), S129–S168.

Competencies

☐ Learn how to use high-frequency energy data from various sources and markets.

☐ Learn how to use and apply machine learning techniques for the analysis of energy markets.

☐ Learn how to use and apply econometric techniques to assess the impacts of the energy transition.

☐ Understand and apply the quantitative methods used to solve complex problems of the energy transition.

☐ Evaluate, with theoretical and quantitative instruments, the complex realities of the energy market to understand its functioning and current challenges.

Learning outcomes

☐ Recognizes the statistical, econometric, and analytical instruments necessary for the economic analysis of energy markets and policies.

☐ Applies analytical and quantitative instruments to energy economics questions, formulating the appropriate hypotheses and using the necessary instruments.

☐ Analyzes complex models of electricity markets.

☐ Uses evidence to solve new problems and develop an adequate analysis.