THE E2E PROJECT'S EDUCATION PROGRAM

A SHORT COURSE ON RANDOMIZED ENERGY-EFFICIENCY EVALUATIONS

BECC WORKSHOP, SACRAMENTO, CALIFORNIA

OCTOBER 15, 2017

Part 1: Randomized Controlled Trials

Instructor: Professor Maximilian Auffhammer (UC Berkeley)

Randomized control trials (RCTs) are the gold standard for evaluating the effectiveness of programs in a wide variety of fields, including medicine, education, and international development. This course will give an overview of RCTs and describe how they can be applied to evaluate energy-efficiency programs. The course will also provide practical suggestions on how RCTs can be implemented and alternative approaches if an RCT is infeasible. The material covered is designed for energy-efficiency professionals with some training in statistics.

Introduction to Randomized Control Trial Research Designs

Topics: Energy-efficiency program evaluators face a difficult task. In order to identify savings from a program, they need to describe how much energy would have been consumed if the program hadn't existed. In other words, they need to provide a "counterfactual" description of the world. This session will describe common approaches to developing counterfactuals, including both observational studies and randomized control trials. We will discuss inherent challenges, including sample selection, statistical biases from omitted variables, and external validity.

Implementing Randomized Control Trials to Evaluate Energy-Efficiency Programs

Topics: A randomized control trial can be designed in many ways, but the treatment and control groups should be identified prior to implementation of the program. This session will describe common issues confronted in developing randomized control trials including identification of the treatment and control groups and the importance of random assignment to these groups. Good treatment and control groups enable an evaluator to pinpoint the impact of a program and eliminate other influences.

While randomized control trials offer an effective way to measure the impacts of a program or policy intervention, it is often neither practical nor appropriate to mandate or force a group of consumers to receive a "treatment." Fortunately, there are experimental research design alternatives that do not require mandatory assignment. This module will introduce some of these alternatives (including randomized encouragement designs, recruit-and-delay, recruit-and-deny).

Quasi-Experimental Approaches

Topics: In some empirical contexts, randomized control trials are simply not practical and/or infeasible. In those cases, quasi-experimental research designs can be an effective substitute. Quasi-experimental studies assign households to treatment and control groups by a method other than random assignment. Their effectiveness depends on program details and the data available. This session describes a set of quasi-experimental approaches, provides examples from the energy efficiency context and discusses their limitations. We will review examples of effective quasi-experimental studies.

Part 2: Machine Learning Methods

Instructor: Professor Mar Reguant (Northwestern University)

In cases where randomized controlled trials are not possible, we need to turn to alternative methods to quantify the savings from energy efficiency programs. Smart meter data creates new opportunities to evaluate energy efficiency programs, but also presents new challenges. Machine learning is an exciting new toolbox that can be used to leverage smart meter data. This course will provide an overview of machine learning and discuss these methods can be used for energy efficiency evaluation. This material is designed for energy-efficiency professionals with some training in statistics.

Machine learning to evaluate energy efficiency projects

Topics: A central challenge in energy efficiency evaluation is figuring out what would have happened in the absence of an energy efficiency upgrade. Machine learning methods are a series of tools for data-driven prediction which are designed to predict well out of sample. In this session, we will provide an overview of existing machine learning methods, including “supervised” tools like LASSO and random forests and “unsupervised” tools like neural networks. We will then discuss how these methods can be used in the context of a specific energy efficiency evaluation, where we use machine learning to generate predictions about counterfactual energy consumption. We will discuss the benefits of using machine learning tools for energy efficiency evaluation, as well as the limitations of this method in a non-randomized setting.

Machine learning to better target energy efficiency projects

Topics: In many cases, energy efficiency projects will work well for some program participants and not for others. Understanding who will benefit from an upgrade can help design cost-effective policy. Because machine learning is designed for prediction, we can use these methods to identify “high-value” participants. In this session, we will discuss how machine learning can be used to understand which interventions are working, and who benefits from these interventions. Using this information, can we use machine learning-based targeting to improve the overall returns from interventions? We will discuss these issues using examples of machine learning applications in real-world energy efficiency interventions.

Instructor Bios:

Maximilian Auffhammer is the George Pardee Jr. Professor of International Sustainable Development and Associate Dean in the Division of Social Sciences at UC Berkeley. Professor Auffhammer received his B.S. in environmental science from the University of Massachusetts at Amherst in 1996, a M.S. in environmental and resource economics at the same institution in 1998 and a Ph.D. in economics from UC San Diego in 2003. He joined the faculty at UC Berkeley in 2003. His research focuses on environmental and resource economics, energy economics and applied econometrics. He is a Research Associate at the National Bureau of Economic Research in the Energy and Environmental Economics group, a Humboldt Fellow, and a lead author for the Intergovernmental Panel on Climate Change (IPCC). Professor Auffhammer serves as Co-Editor of the Journal of the Association of Environmental and Resource Economists. His research has appeared in The American Economic Review, the Review of Economic Studies, The Review of Economics and Statistics, The Economic Journal, the Proceedings of the National Academies of Sciences, the Journal of Environmental Economics and Management, The Energy Journal and other academic journals. Professor Auffhammer is the recipient of the 2007 Cozzarelli Prize awarded by the National Academies of Sciences, the 2009 Campus Distinguished Teaching Award and the 2007 Sarlo Distinguished Mentoring Award.

Mar Reguant is an assistant professor in the Department of economics at Northwestern University. Professor Reguant received her Ph.D. in economics from the Massachusetts Institute of Technology in 2011. She began her career as an assistant professor at the Stanford Graduate School of Business in 2011 and was a visiting professor at the Toulouse School of economics for a year. Her research deals with the economics of energy, with an emphasis on electricity and the pollution associated with electricity generation. She is a Faculty Research Fellow at the National Bureau of Economic Research in the Energy and Environmental Economics group and the industrial organization group. She is also the associate editor of the *Journal of Industrial Economics, International Journal of Industrial Organization*, and of the *Journal of the Spanish Economic Association*. In 2016, she received a prestigious Sloan Research Fellowship from the Alfred P. Sloan Foundation. Her research has appeared in The American Economic Review, the Review of Economic Studies, and the Journal of Political Economy.