ARE 261 Module 1
Empirical Energy and Environmental Economics
332 Giannini Hall
Tuesday/Thursday 2-3:30

Department of Agricultural and Resource Economics
UC Berkeley, Spring 2021

Instructor: **Meredith Fowlie**
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Office hours: **Friday 2-3pm**

Course description: This course is designed to help prepare graduate students to conduct empirical research in energy and environmental economics (EEE). The course builds on material covered in ARE 212 and 213 and has two broad objectives. The first is to develop a deeper understanding of empirical methods and research designs that are commonly used in the field of energy and environmental economics. The second is to familiarize students with important empirical findings at the frontier of the field.

Prerequisites: Students must be familiar with the econometric methods covered in ARE 212 and 213. Previous coursework in environmental economics will also be helpful, but not required.

Assignments and grading: 50% of the final grade is based on Joe Shapiro's portion of the course and 50% based on this part. My half is comprised of the following components:

- **Problem sets (60%)** I will assign two problem sets that emphasize applications of methods we are discussing. These can be completed in small groups, but each student must write up his or her own responses.
- **Class participation (30%)** Participation is based on in-class contributions to paper discussions and short written responses to reading assignments. I will post prompt questions about assigned discussion papers before lecture and ask you to submit short responses before class.
- **Research sketch (10%)** A goal of the class is to help you generate research ideas of your own. At the end of the semester, each student will present a preliminary research idea related to one of the topics we cover in class. We will debrief/react to the idea as a group. A two-page research summary will be due at the time of the presentation. ARE students, this pitch cannot be a re-pitch of your second-year paper!

Auditing the class: Students are welcome to audit the course provided they have taken the pre-requisite courses and are prepared to participate actively in class (this includes submitting responses to the assigned prompt questions). Auditors are not required to complete problem sets or make a research idea presentation.

Textbook: We will pick and choose from a variety of texts, papers, and resources. Lecture content will draw most heavily from the following resources:

- Imbens, Guido and Donald Rubin. *Causal Inference in Statistics and Social Sciences* (2015).

- Train, Kenneth (2009). *Discrete Choice Models with Simulation.* Cambridge University Press.
- Wooldridge, J., (2001), *Econometric Analysis of Cross Section and Panel Data*. MIT Press.

Public health guidelines. As of 8/2021, UC Berkeley guidelines are that *all* individuals on campus should complete a daily symptom screener: https://calberkeley.ca1.qualtrics.com/jfe/form/SV_3xTgcs162K19qRv and wear masks for any day indoors on campus.

These guidelines may evolve, but please take current guidelines seriously. This class values active in-person participation, but if you have any cold or related symptoms, please keep everyone healthy and stay home.

If you do have any symptoms within 24 hours of class, just email me and I will setup a live zoom link so you can join remotely. I can also record the class and post online. Please let's all keep each other healthy!

I. Getting oriented

Angrist and Jorn-Steffen Pischke (2010). "The Credibility Revolution in Empirical Economics: How Better Research Design is Taking the Con out of Econometrics." *Journal of Economic Perspectives*, Spring 2010.

Heckman, James (2010). "Building Bridges Between Structural and Program Evaluation Approaches to Evaluating Policy". *Journal of Economic Literature,* 48(2).

Keane, Michael (2010). "Structural vs. Atheoretical Approaches to Econometrics." *Journal of Econometrics*, Vol 156.

Nevo, A. and Whinston, M. (2010). "Taking the Dogma out of Econometrics: Structural Modeling and Credible Inference." *The Journal of Economic Perspectives*, 24(2):69-81.

Timmins, Christopher and Schlenker, Wolfram (2009). "Reduced-Form Versus Structural Modeling in Environmental and Resource Economics". *Annual Review of Resource Economics*, 1(1): 351-380.

II. Randomized field experiments

Burlig, Fiona, Louis Preonas and Matt Woerman (2019) "Panel Data and Experimental Design"

Card, David, Stefano DellaVigna and Ulrike Malmendier (2011). "The Role of Theory in Field Experiments." *Journal of Economic Perspectives*, 25(3): 39-62.

Duflo, Esther & Glennerster, Rachel & Kremer, Michael (2008). "Using Randomization in Development Economics Research: A Toolkit", *Handbook of Development Economics*.

Application 1: Energy demand

Allcott, Hunt (2015). "Site Selection Bias in Program Evaluation". *Quarterly Journal of Economics*. 2015; 130 (3): 1117-1165.

Fowlie, Meredith, Michael Greenstone, and Catherine Wolfram (2018). "Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistance Program", *Quarterly Journal of Economics*.

Christensen, Peter, Paul Francisco, Erica Meyers, and Mateus Souza (2020) "Decomposing the Wedge between Projected and Realized Returns from Energy Efficiency Investments", *Forthcoming in the Review of Economics and Statistics*.

Fowlie, Meredith, Catherine Wolfram, Patrick Baylis, Anna Spurlock, Annika Todd, Peter Cappers (2020) "Default Effects and Follow-on Behavior: Evidence from an Electricity Pricing Program". Forthcoming in *Review of Economic Studies.*

Greer K. Gosnell, John A. List, and Robert D. Metcalf (2020) "The Impact of Managerial Practices on Employee Productivity: A Field Experiment with Airline Captains". *Journal of Political Economy,* Vol 18(4).

Hahn, Robert W., and Robert D. Metcalfe. 2021. "Efficiency and Equity Impacts of Energy Subsidies." *American Economic Review*, 111 (5): 1658-88.

Knittel, Chris and Samuel Stoppler (2019). "Using Machine Learning to Target Treatment: The Case of Household Energy Use". NBER WP26531.

Application 2: Development, environment, and energy

Berkouwer, Susanna and Joshua Dean (2019). "Credit and Attention in the Adoption of Profitable Energy Efficient Technologies in Kenya." UC Berkeley Working Paper.

Carranza, Eliana and Robyn Meeks (2020). "Energy Efficiency and Electricity Reliability". *Review of Economics and Statistics.*

Duflo, Esther, Michael Greenstone, Rohini Pande and Nicholas Ryan (2013). Truth-telling by Third-Party Auditors and the Response of Polluting Firms: Experimental Evidence from India. *Quarterly Journal of Economics*, 128 (4): 1499-1545.

Jayachandran, Seema, Joost de Laat, Eric Lambin, and Charlotte Stanton (2016). "Cash for Carbon: A Randomized Controlled Trial of Payments for Ecosystem Services to Reduce Deforestation." *Science* 357(6348).

Lee, Ken, Edward Miguel, and Catherine Wolfram (2019). "Experimental Evidence on the Economics of Rural Electrification". *Journal of Political Economy,* forthcoming.

Pattanayaka, S.K. et al. (2020) "Experimental evidence on promotion of electric and improved biomass cookstoves". *Proceedings of the National Academies of Science.*

III. Instrumental variables

Angrist, Joshua and Alan Krueger. 2001. "Instrumental Variables and the Search for Identification: From Supply and Demand to Natural Experiments", *Journal of Economic Perspectives* 15(4), Fall 2001

Bishop, Kelley and Nicolai V. Kuminoff and H. Spencer Banzhaf and Kevin J. Boyle and Kathrine von Gravenitz and Jaren C. Pope and Vincent Kerry Smith and Christopher D. Timmins (2019). "Best Practices in Using Hedonic Property Value Models for Welfare Measurement". *Review of Environmental Economics and Policy,* forthcoming.

Conley, Timothy, Christian B. Hansen and Peter E. Rossi. 2012. "Plausibly Exogenous," *The Review of Economics and Statistics*, MIT Press, vol. 94(1), pages 260-272

Deaton, A. 2010. "Instruments, randomization, and learning about development*," Journal of Economic Literature*, pages 424-455.

Application: IV meets air pollution meets big data

Anderson, M. L. (2015). As the Wind Blows: The Effects of Long-Term Exposure to Air Pollution on Mortality. *NBER Working Paper*, (w21578).

Chay, Kenneth and Michael Greenstone (2005). "Does Air Quality Matter? Evidence from the Housing Market," *Journal of Political Economy*, University of Chicago Press, vol. 113(2), pages 376-424, April.

Deryugina, Tatyana, Garth Heutel, Nolan H. Miller, David Molitor, and Julian Reif. 2019. "The Mortality and Medical Costs of Air Pollution: Evidence from Changes in Wind Direction." *American Economic Review*, 109 (12): 4178-4219.

Di, Qian, Yan Wang, Antonella Zanobetti, Yun Wang, Petros Koutrakis, Christine Choirat, Francesca Dominici, Joel D. Schwartz (2017). "Air Pollution and Mortality in the Entire Medicare Population," *New England Journal of Medicine*.

Grosset, Florian and Wolfram Schlenker (2021) "Pushed to Cross the Line: Multiperiod Pollution Standards and the Cost of Environmental Regulation"

Johnson, Reid, Jacob LaRiviere, and Hendrik Wolff (2018_. "Fracking, Coal, and Air Quality". *Journal of the Association of Environmental and Resource Economists.,* 6(5).

IV. Panel data and differences-in-differences

Abadie, Alberto, David Drukker, Jane Leber Herr & Guido W. Imbens (2004). "Implementing matching estimators for average treatment effects in Stata," *Stata Journal*, StataCorp LP, vol. 4(3), pages 290-311.

Heckman, J.J., H. Ichimura, and P. E. Todd (1997). "Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme," Review of Economic Studies, 64: 605-654.

Application 1: Electricity markets

Cicala, Steve (2020) "Imperfect Markets versus Imperfect Regulation in U.S. Electricity Generation," Forthcoming in the *American Economic Review.*

Davis, Lucas W. and Catherine D. Wolfram. 2012. "Deregulation, Consolidation and Efficiency: Evidence from U.S. Nuclear Power," American Economic Journal: Applied Economics, 2012, 4(4), 194-225

Deryugina, Tatyana, Alexander MacKay, and Julian Reif. 2020. "The Long-Run Dynamics of Electricity Demand: Evidence from Municipal Aggregation." *American Economic Journal: Applied Economics*, 12 (1): 86-114.

Ito, Koichiro (2012). "Do Consumers Respond to Marginal or Average Price? Evidence from Nonlinear Electricity Pricing." *American Economic Review*.

Shaffer Blake (2020). "Misunderstanding nonlinear prices: Evidence from a natural experiment in electricity demand". *American Economic Journal: Economic Policy*. 12(3).

Application 2: Emissions markets and equity

Fowlie, Meredith, Stephen P. Holland, and Erin Mansur (2012) "What Do Emissions Markets Deliver and to Whom? Evidence from Southern California's NOx Trading Program". *American Economic Review*. 102(2): 965-93.

Corbett Grainger & Thanicha Ruangmas (2018). "Who Wins from Emissions Trading? Evidence from California," Environmental & Resource Economics, European Association of Environmental and Resource Economists, vol. 71(3).

Hernandez-Cortes, Danae and Kyle Meng (2020). "Do Environmental Markets Cause Environmental Injustice? Evidence from California's Carbon Market". NBER WP27205.

Mansur, Erin and Glenn Sheriff (2021) "On the measurement of environmental inequality: Ranking emissions distributions generated by different policy instruments." Forthcoming in the *Journal of the Association of Environmental and Resource Economists,* 6(5).

Application 3: Wildfire

Baylis, Patrick and Judd Boomhower (2021) "Building Codes and Community Resilience to Natural Disasters".

Bishop, Kelly and A. Murphy (2019) "Valuing Time-Varying Attributes using the Hedonic Model: When is a Dynamic Approach Necessary?" *Review of Economics and Statistics.*

Burke, Marshall, Anne Driscoll, Sam Heft-Neal, Jiani Xue, Jennifer Burney, Michael Wara (2021) "The changing risk and burden of wildfire in the United States." *Proceedings of the National Academy of Sciences,* 118 (2).

McCoy, Shawn and Randall P. Walsh (2018). "Wildfire Risk, Salience & Housing Demand." *Journal of Environmental Economics and Management*, Volume 91.

IV. Discrete choice models

Train: Chapters 2,3,6, 13

Some energy applications

Brownstone, D., Train, K. (1999) "Forecasting new product penetration with flexible substitution patterns. Journal of Econometrics". *Journal of Econometrics.* 89: 109—129

Burgess, Robin, Michael Greenstone, Nicholas Ryan, Anant Sudarshan (2020). "The Role of Decentralized Solar in Completing Indian Electrification"

Davis, Lucas (2021). "What Matters for Electrification? Evidence from 70 Years of US Home Heating Choices.

Revelt, David, and Kenneth Train (1998). "Mixed logit with repeated choices: households' choices of appliance efficiency level." *Review of Economics and Statistics* 80.4: 647-657.

V. Structural econometric identification and differentiated product markets

Berry, Steve, James Levinsohn and Ariel Pakes (1995), " Automobile Prices in Market Equilibrium", Econometrica 63 (July 1995), 841-890.

Knittel, Christopher R., and Konstantinos Metaxoglou. "Estimation of random-coefficient demand models: Two empiricists' perspective." *Review of Economics and Statistics* 96, no. 1 (2014): 34-59.

Nevo, Aviv. 2000. "A Practitioner's Guide to Estimation of Random Coefficients Logit Models of Demand," Journal of Economics & Management Strategy, 9(4), 513-548.

Application 1: Consumer Choice of Energy Consuming Durables (cars, appliances)

Berry, Steven, James Levinsohn, and Ariel Pakes (2004). "Differentiated products demand systems from a combination of micro and macro data: The new car market." *Journal of Political Economy* 112(1): 68-105.

Busse, Meghan R., Christopher R. Knittel, and Florian Zettelmeyer (2013). "Are Consumers Myopic? Evidence from New and Used Car Purchases." *American Economic Review*, 103(1): 220-56.

Grigolon, Laura, Mathias Reynaert, and Frank Verboven (2018). "Consumer Valuation of Fuel Costs and the Effectiveness of Tax Policy - Evidence from the European Car Market", *American Economic Journal: Economic Policy*, vol. 10, n. 3, August 2018, pp. 193–225.

Houde and Myers (2019). "Heterogeneous (Mis-) Perceptions of Energy Costs: Implications for Measurement and Policy Design". Working Paper.

Ito, Koichiro and Shuang (2019) "Zhang Willingness to Pay for Clean Air: Evidence from Air Purifier Markets in China". *Journal of Political Economy.*

Sallee, James (2014). "Rational inattention and energy efficiency". *The Journal of Law and Economics* 57 (3), 781-820

Train, Kenneth and Clifford Winston (2007). "Vehicle Choice Behavior and the Declining Market Share of U.S. Automakers", *International Economic Review* Vol. 48, No. 4 (Nov., 2007), pp. 1469-149.

Whitefoot, Kate, Meredith Fowlie, and Steven Skerlos (2017) "Influence of Acceleration Tradeoffs on CO2 Emissions and Costs of Fuel Economy and Greenhouse Gas Regulations". Forthcoming in *Environmental Science and Technology*

Application 2: Neighborhood Sorting, property markets, and environmental justice

Banzhaf, Spencer, Lala Ma, and Christopher Timmins (2018). "Environmental Justice: The Economics of Race, Place, and Pollution". *Journal of Economic Perspectives,* forthcoming.

Boyle, Kevin, Nicholas Kuminoff, and Congwen Zhang (2015) Partial Identification of Amenity Demand Functions (2015) *Journal of Environmental Economics and Management*

Depro, Brooks, Christopher Timmins, and Maggie O'Neil (2015) "White Flight and Coming to the Nuisance: Can Residential Mobility Explain Environmental Injustice?," *Journal of the Association of Environmental and Resource Economists* 2, no. 3 (September 2015): 439-468.

Kuminoff, Nicolai V, V. Kerry Smith and Christopher Timmins (2013). "The New Economics of Equilibrium Sorting and Policy Evaluation Using Housing Markets." *Journal of Economic Literature*, 51(4): 1007-62.

Fowlie, Meredith, Reed Walker, and David Wooley (2020). "Climate Policy, Environmental Justice, and Local Air Pollution". ***Brookings Economic Studies Program.***

Rothstein, Richard. "Suppressed Incomes", *The Color of Law.* W.W. Norton, 2017.

Taylor, Dorceta. "Market Dynamics Residential Mobility, or Who Moves and Who Stays" *Toxic Communities : Environmental Racism, Industrial Pollution, and Residential Mobility*. NYU Press, 2014.

VI. Dynamic discrete choice (time permitting)

Aguirregabiria, Victor and Pedro Mira (2010). "Dynamic discrete choice structural models: A survey." *Journal of Econometrics,* 156(1),38-67.

Bell, Samuel, Kelsey Jack, Chris Severen, Elizabeth Walker (2020). "Technology Adoption under Uncertainty: Take-up and Subsequent Investment in Zambia" *The Review of Economics and Statistics*) 102 (3): 617–632.

Rust, John (1987). "Optimal Replacement of GMC Bus Engines: An Empirical Model of Harold Zurcher" *Econometrica*, Vol. 55, No. 5.

Tentative Schedule and discussion papers

TR August 26	**Intro/Field experimental designs**
T August 30	**RCTs/REDs** ***Choose one of:*** DP: Fowlie, Meredith, Michael Greenstone, and Catherine Wolfram (2018). "Do Energy Efficiency Investments Deliver? Evidence from the Weatherization Assistance Program", *Quarterly Journal of Economics*. DP: Hahn, Robert W., and Robert D. Metcalfe. 2021. "Efficiency and Equity Impacts of Energy Subsidies." *American Economic Review*, 111 (5): 1658-88.
R Sept 2	**Power calcs; SUTVA ; Development applications** DP: Carranza, Eliana and Robyn Meeks (2020). "Energy Efficiency and Electricity Reliability". *Review of Economics and Statistics*
T Sept 7	**Quasi-experimental designs: IV and local air pollution** DP: Deryugina, Tatyana, Garth Heutel, Nolan H. Miller, David Molitor, and Julian Reif. 2019. "The Mortality and Medical Costs of Air Pollution: Evidence from Changes in Wind Direction." *American Economic Review*, 109 (12): 4178-4219.
R Sept 9	**FE-IV Applications: Electricity supply and demand** ***Choose one of:*** DP: Ito, Koichiro (2012). "Do Consumers Respond to Marginal or Average Price? Evidence from Nonlinear Electricity Pricing." *American Economic Review*.
T Sept 14	**FE-IV Applications: Emissions markets and equity** DP: Hernandez-Cortes, Danae and Kyle Meng (2020). "Do Environmental Markets Cause Environmental Injustice? Evidence from California's Carbon Market". NBER WP 27205.
R Sept 16	**FE-IV Applications: Wildfire** DP: Baylis, Patrick and Judd Boomhower (2021) "Building Codes and Community Resilience to Natural Disasters".
T Sept 21	**Discrete choice/logit fundamentals** *Lecture notes;* **DP:** Davis, Lucas (2021) What Matters for Electrification? Evidence from 70 Years of U.S. Home Heating Choices
R Sept 23	**Mixed logit** *Lecture notes* DP: Burgess, Robin, Michael Greenstone, Nicholas Ryan, Anant Sudarshan (2020). "The Role of Decentralized Solar in Completing Indian Electrification"
T Sept 28	**Structural demand models: differentiated products** *BLP; no paper summary*
R Sept 30	**Durable goods applications** *Choose one:* DP: Grigolon, Laura, Mathias Reynaert, and Frank Verboven (2018). "Consumer Valuation of Fuel Costs and the Effectiveness of Tax Policy - Evidence from the European Car Market", *American Economic Journal: Economic Policy*, vol. 10, n. 3, August 2018, pp. 193–225.

	DP: Ito, Koichiro and Shuang (2019) “Zhang Willingness to Pay for Clean Air: Evidence from Air Purifier Markets in China”. *Journal of Political Economy*
T Oct 5	**BLP: Neighborhood choice models/environmental justice** *Read both:* DP: Depro, Brooks, Christopher Timmins, and Maggie O’Neil (2015) "White Flight and Coming to the Nuisance: Can Residential Mobility Explain Environmental Injustice?," *Journal of the Association of Environmental and Resource Economists* 2, no. 3 (September 2015): 439-468. DP: Taylor, Dorceta. “Market Dynamics Residential Mobility, or Who Moves and Who Stays” *Toxic Communities : Environmental Racism, Industrial Pollution, and Residential Mobility*. NYU Press, 2014.
R Oct 7	**Dynamic discrete choice** DP: Bell, Samuel, Kelsey Jack, Chris Severen, Elizabeth Walker (2020). “Technology Adoption under Uncertainty: Take-up and Subsequent Investment in Zambia” *The Review of Economics and Statistics.* 102 (3): 617–632.