DRAFT

ECON 50a / HKS SUP 135
Using Big Data to Solve Economic and Social Problems

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COURSE DESCRIPTION

Economics 50a will show how "big data" can be used to understand and address some of the most important social and economic problems of our time. The course will give students an introduction to frontier research and policy applications in economics and social science in a non-technical manner that does not require prior coursework in economics or statistics, making it suitable both for students exploring economics for the first time, as well as for more advanced students. The course will include discussions with leading researchers and practitioners, who use big data in real-world applications.

Topics include equality of opportunity, education, racial disparities, innovation and entrepreneurship, health care, climate change, criminal justice, tax policy, and poverty in developing countries. In the context of these topics, the course will provide an introduction to basic methods in data science, including regression, causal inference, and machine learning.

In empirical projects and weekly labs, students will work with real data to learn how the methods discussed in the course can be implemented in practice.

Students will participate in weekly labs, collaborative work, and discussions with leading researchers and practitioners. The class content will include short videos featuring Raj Chetty, Gregory Bruich, and others.

COURSE MECHANICS

1. Mondays 1:30-2:45 p.m.: Live lectures and discussions on Zoom

2. Wednesdays 1:30-2:45 p.m. (and additional times to accommodate students in all time zones): Live coding lab on Zoom designed to give you hands-on experience in *doing* economics yourself by working through empirical problems in small groups with peers and your teaching fellow.

3. Pre-recorded videos: posted on Mondays to be viewed by the following Monday. Following best practices in online learning, the videos will be accompanied by interactive questions.

4. In lieu of exams, students will complete four empirical projects, submit weekly lab assignments, complete the interactive questions that go along with the pre-recorded videos, and attend the live lectures, discussions, and labs.

This semester's course will include discussions with Paul Novosad on intergenerational mobility in India, Amanda Pallais on college financial aid, Michael Tubbs on the Stockton Economic Empowerment Demonstration and other initiatives in Stockton, CA, Ziad Obermeyer on machine learning in health, Nicole Maestas on the opioid epidemic, Frances Moore on climate change, and Raj Chetty on new research at Opportunity Insights on economic opportunity.

COURSE GOALS

The course has three principal learning objectives: 1) to introduce students to frontier social science research on key social and economic issues, 2) to teach students how to analyze data using modern quantitative methods and basic programming techniques, and 3) to show students to how practitioners are using data to analyze social problems.

PEDAGOGICAL APPROACH

We seek to teach economics like a laboratory science, showing students how to *do* economics rather than presenting lectures about long-established results. Our approach draws inspiration from research on best practices in teaching in other settings. Mehta and Fine (2019) compared teaching practices across high school courses and found that in the most effective classes, *"rather than touring students through the textbook, teachers invited students to participate in the authentic work of the field….For example, a skillful science teacher in a high-poverty-district high school offered a course in which her students designed, researched, carried out and wrote up original experiments."* We seek to apply this approach to teaching introductory empirical economics by discussing frontier research in lectures and having students engage in research themselves in labs and empirical projects. This is a work in progress, and we welcome your feedback on how we can improve this class as we teach the course at Harvard and also seek to support this approach at other colleges and high schools.

GENERAL EDUCATION AND OTHER CREDIT

This class satisfies the Quantitative Reasoning with Data (QRD) general education requirement. This class (when taken for a letter grade) meets the writing elective requirement for the Economics concentration. It also is an approved economics elective for the Applied Math-Economics concentration and the Economics Secondary Field. It counts towards the Technology and Governance Requirement for the Government Department's Tech Science program.

This class is a course connector with Statistics 10/Computer Science 10/Data Science 10. Students who enroll in both classes concurrently may be able to have overlap between their final projects for both classes, although the project must be approved by both courses' faculties and expectations are higher for a project that is being used for both courses since it reflects effort and skills for two courses.

This class is intended to complement Econ 10a/b by focusing on statistical methods and showing students how to apply the tools of economics using modern data science techniques.

EMPIRICAL PROJECTS

A key learning element of the course will be four empirical projects, which will give students hands-on experience in doing economics and working with data. We will teach and support the statistical software program Stata 16 and R for these projects, but students are welcome to use other programs (e.g., SAS, SPSS, Python), provided that their code and work is clearly documented. The empirical projects are more substantial than traditional problem sets and will include significant coding, reading, and writing elements that will put students in the shoes of social scientists doing research. Labs will be structured to provide the tools necessary to solve the empirical projects, and support will be provided so that coding skill is not a hindrance to achieving success on the projects.

READINGS

There is no textbook for the course because the material is based entirely on recent research papers, mostly written within the past few years. Students are responsible for reading a small number of research papers, which appear in bold on the course reading list below. As we go along, we will let you know when each of the required readings should be done. Please focus on understanding the main ideas, rather than technical details. We recommend starting with non-technical summaries and introductions of research papers for this purpose.

GRADING

The class grade will be based on empirical projects (40%), lab assignments (40%), and pre-recorded video questions and attendance at live lectures, guest discussions, and labs (20%). The distribution of grades in this course will be similar to other large General Education courses at Harvard.

PASS/FAIL: Students may opt to take the course pass/fail.

ACADEMIC ACCOMMODATIONS: Students needing academic accommodations because of a documented disability must present their Faculty Letter from the Accessible Education Office (AEO) by Wednesday, February 3.

COLLABORATION POLICY: Discussion and the exchange of ideas are essential to academic work. You are encouraged to consult with your classmates on the empirical projects and to share sources. However, you should ensure that any work you submit for evaluation is the result of your own research and that it reflects your own approach to the topic. You must also adhere to standard citation practices and properly cite any books, articles, websites, lectures, etc. that have helped you with your work. If you received any help with your work (e.g., feedback on drafts, help with code or programming), you must also acknowledge this assistance.

ACADEMIC INTEGRITY: You are expected to uphold the Harvard College honor code and abide by the other University policies on academic honesty and integrity as given in the Harvard College Handbook for Students. As required by the College, all instances of suspected cheating will be referred to the Administrative Board.

CLASS SCHEDULE (subject to change)

Part I: Inequality and Social Mobility		
Monday	1/25/2021	Using Big Data for Social Good [Bruich]
Wednesday	1/27/2021	Lab 1: Introductory Statistical Concepts and Statistical Computing
Monday	2/1/2021	Discussion with Paul Novosad, Professor of Economics, Dartmouth College
Wednesday	2/3/2021	Lab 2: Measuring Upward Mobility Using the National Longitudinal Survey
Monday	2/8/2021	Causal Effects of Neighborhoods [Bruich]
Wednesday	2/10/2021	Lab 3: Using Big Data to Measure and Understand Upward Mobility
Monday	*2/15/2021*	*No class - Presidents' Day*
Wednesday	2/17/2021	Lab 4: Upward Mobility in India
Part II: Education		
Monday	2/22/2021	Education [Bruich]
Wednesday	2/24/2021	Lab 5: The Moving to Opportunity Experiment
Monday	*3/1/2021*	*No class - Wellness Day*
Wednesday	3/3/2021	Lab 6: The Tennessee STAR Experiment
Monday	3/8/2021	Discussion with Amanda Pallais, Professor of Economics, Harvard University
Wednesday	3/10/2021	Lab 7: Evaluating Education Policy with Regression Discontinuity Designs
Part III: Racial Disparities, Implicit Bias, and Algorithmic Bias		
Monday	3/15/2021	Discussion with Michael Tubbs, Former Mayor of Stockton, California
Wednesday	3/17/2021	Lab 8: Prediction Using Decision Trees and Regression
Monday	3/22/2021	Measuring Implicit Bias [Bruich]
Wednesday	3/24/2021	Lab 9: Prediction Using Cross Validation and Random Forests
Part IV: Health		
Monday	3/29/2021	Discussion with Ziad Obermeyer, Professor of Health Policy and Management at the Berkeley School of Public Health, and Co-Founder of the Laboratory for Systems Medicine
Wednesday	*3/31/2021*	*No class - Wellness Day*
Monday	4/5/2021	Discussion with Nicole Maestas, Professor, Harvard Medical School, Dept. of Health Care Policy
Wednesday	4/7/2021	Lab 10: Bias in Algorithms

Part V: Climate Change

Monday	4/12/2021	Discussion with Frances Moore, Professor of Environmental Science and Policy at Univ. of California, Davis
Wednesday	4/14/2021	Lab 11: Evaluating Policy using Differences in Differences

Part VI: Recent Research at Opportunity Insights

Monday	4/19/2021	Discussion with Raj Chetty, Professor of Economics, Harvard University
Wednesday	4/21/2021	Lab 12: Evaluating Policy using Synthetic Control Methods
Monday	4/26/2021	Conclusion: Reoccurring Themes and General Lessons [Bruich]
Wednesday	4/28/2021	Lab 13: Propensity Score Methods

COURSE READINGS

Students are responsible for reading a small number of required papers (in bold below). Please focus on understanding the main ideas, rather than technical details. We recommend starting with non-technical summaries and introductions for this purpose. The other papers will be discussed in lecture, in section, or in the empirical projects, and may be useful references in those contexts.

Part I: Equality of Opportunity

Geography of Economic Mobility

Chetty, Raj, John Friedman, Nathaniel Hendren, Maggie R. Jones, and Sonya R. Porter. 2018. "The Opportunity Atlas: Mapping the Childhood Roots of Social Mobility." NBER Working Paper No. 25147. Non-technical summary.

Chetty, Raj, Nathaniel Hendren, Patrick Kline, and Emmanuel Saez. 2014. "Where Is the Land of Opportunity? The Geography of Intergenerational Mobility in the United States." *Quarterly Journal of Economics* 29 (4): 1553–1623. Non-technical summary.

Asher, Sam, Paul Novosad, and Charlie Rafkin. 2019. "Intergenerational Mobility in India: Estimates from New Methods and Administrative Data." Dartmouth Working Paper.

Alesina, Alberto, Sebastian Hohmann, Stelios Michalopoulos, Elias Papaioannou. 2021. "Intergenerational Mobility in Africa," *Econometrica* 89(1): 1-35.

Policies to Improve Upward Mobility

Bergman, Peter, Raj Chetty, Stefanie DeLuca, Nathaniel Hendren, Lawrence F. Katz, and Christopher Palmer. 2019. "Creating Moves to Opportunity: Experimental Evidence on Barriers to Neighborhood Choice," NBER Working Paper No. 26164. Non-technical summary

Chetty, Raj, Nathaniel Hendren, and Lawrence F. Katz. 2016. "The Effects of Exposure to Better Neighborhoods on Children: New Evidence from the Moving to Opportunity Experiment." *American Economic Review* 106 (4): 855–902. Non-technical summary

Chetty, Raj, and Nathaniel Hendren. 2018. "The Impacts of Neighborhoods on Intergenerational Mobility I: Childhood Exposure Effects." *Quarterly Journal of Economics* 133(3): 1107-1162. Non-technical summary.

Dobbie, Will, and Roland G. Fryer Jr. 2011. "Are High-Quality Schools Enough to Increase Achievement among the Poor? Evidence from the Harlem Children's Zone," *American Economic Journal: Applied Economics*, 3 (3): 158-87.

Pollack, Craig E., Amanda L. Blackford, Shawn Du, Stefanie Deluca, Rachel J.L. Thornton, and Bradley Herring. 2019. "Association of Receipt of a Housing Voucher With Subsequent Hospital Utilization and Spending," *Journal of the American Medical Association* 322(21): 2115-2124.

Historical Trends

Autor, David H. 2014. "Skills, education, and the rise of earnings inequality among the 'other 99 percent.'" *Science* 344(6186): 843-85.

Berman, Yonatan. 2019. "The Long Run Evolution of Absolute Intergenerational Mobility." Working paper.

Chetty, Raj, David Grusky, Maximilian Hell, Nathaniel Hendren, Robert Manduca, and Jimmy Narang. 2017. "The Fading American Dream: Trends in Absolute Income Mobility Since 1940." *Science* 356 (6336): 398-406. Non-technical summary

Deming, David J. 2017. "The Growing Importance of Social Skills in the Labor Market," *Quarterly Journal of Economics* (132)4: 1593–1640.

Goldin, Claudia and Lawrence Katz. 2010. *The Race Between Education and Technology* Belknap Press of Harvard University Press, Cambridge, Mass.

Hendren, Nathaniel, and Ben Sprung-Keyser. 2020. "A Unified Welfare Analysis of Government Policies," *Quarterly Journal of Economics* (Forthcoming).

Piketty, Thomas and Emmanuel Saez. 2003. "Income Inequality in the United States, 1913-1998." *Quarterly Journal of Economics* 118(1): 1-39.

Saez, Emmanuel and Gabriel Zucman. 2016. "Wealth Inequality in the United States since 1913: Evidence from Capitalized Income Tax Data." *Quarterly Journal of Economics* 131(2): 519-578.

Innovation, Mobility, and Growth

Bell, Alex, Raj Chetty, Xavier Jaravel, Neviana Petkova, and John Van Reenen. 2019. "Who Becomes an Inventor in America? The Importance of Exposure to Innovation." *Quarterly Journal of Economics* 134(2): 715–783. Non-technical summary

Bian, Lin, Sarah-Jane Leslie, and Andrei Cimpian. 2017. "Gender Stereotypes about Intellectual Ability Emerge Early and Influence Children's Interests." *Science* 391 (6323): 389–91.

Part II: Education

Higher Education

Chetty, Raj, John N. Friedman, Emmanuel Saez, Nicholas Turner, and Danny Yagan. 2018. "Income Segregation and Intergenerational Mobility Across Colleges in the United States," *Quarterly Journal of Economics*, 2020. Non-technical summary

Dynarski, Susan, C.J. Libassi, Katherine Michelmore, and Stephanie Owen. 2018. "Closing the Gap: The Effect of a Targeted, Tuition-Free Promise on College Choices of High-Achieving, Low-Income Students." NBER Working Paper No. 25349

Ekowo, Manuela and Iris Palmer. 2016. The Promise and Peril of Predictive Analytics in Higher Education. New America Education Policy Program Report.

Hoxby, Caroline, and Sarah Turner. 2013. "Expanding College Opportunities for High-Achieving, Low Income Students." *Stanford Institute for Economic Policy Research Discussion Paper*, no. 12-014: 1–57.

Zimmerman, Seth D. 2014. "The Returns to College Admission for Academically Marginal Students." *Journal of Labor Economics* 32(4): 711-754.

Primary Education

Chetty, Raj, John N. Friedman, Nathaniel Hilger, Emmanuel Saez, Diane Whitmore Schanzenbach, and Danny Yagan. 2011. "How Does Your Kindergarten Classroom Affect Your Earnings? Evidence from Project STAR." ***Quarterly Journal of Economics*** **126 (4): 1593–1660. Non-technical summary**

Chetty, Raj, John N. Friedman, and Jonah E Rockoff. 2014. "Measuring the Impacts of Teachers I: Evaluating Bias in Teacher Value-Added Estimates." *American Economic Review* 104 (9): 2593–2632. Non-technical summary

Chetty, Raj, John N. Friedman, and Jonah E. Rockoff. 2011. "Measuring the Impacts of Teachers II: Teacher Value-Added and Student Outcomes in Adulthood." *American Economic Review* 104 (9): 2633–79. Non-technical summary

Fredriksson, Peter, Björn Öckert, and Hessel Oosterbeek. 2013. "Long-Term Effects of Class Size." *Quarterly Journal of Economics* 128 (1): 249–85.

Reardon, Sean. 2016. "School Segregation and Racial Academic Achievement Gaps." *Russell Sage Foundation Journal of the Social Sciences* 2 (5): 34–57.

Reardon, S. F., Ho, A. D., Shear, B. R., Fahle, E. M., Kalogrides, D., Jang, H., Chavez, B., Buontempo, J., & DiSalvo, R. (2019). Stanford Education Data Archive (Version 3.0). https://edopportunity.org/

Charter Schools

Abdulkadiroğlu, Atila, Joshua D. Angrist, Susan M. Dynarski, Thomas J. Kane, and Parag A. Pathak. 2011. "Accountability and Flexibility in Public Schools: Evidence from Boston's Charters and Pilots." *Quarterly Journal of Economics* 126 (2): 699–748.

Dobbie, Will, and Roland G. Fryer. 2011. "Are High-Quality Schools Enough to Increase Achievement among the Poor? Evidence from the Harlem Children's Zone." *American Economic Journal: Applied Economics* 3 (3): 158–87.

Part III: Racial Disparities

Racial Disparities and Segregation

Chetty, Raj, Nathaniel Hendren, Maggie R. Jones, and Sonya R. Porter. 2018. "Race and Economic Opportunity in the United States: An Intergenerational Perspective." *Quarterly Journal of Economics* 135(2): 711–783. Non-technical summary

Fryer, Roland G., and Steven Levitt. 2004. "Understanding the Black-White Test Score Gap in the First Two Years of School." *Review of Economics and Statistics* 86 (2): 447-464.

Looney, Adam and Nicolas Turner. 2017. "Work and Opportunity Before and After Incarceration." Economic Studies at The Brookings Institute Technical Report.

Pager, Devah. 2003. "The Mark of a Criminal Record." *American Journal of Sociology* 108(5): 937-975.

Discrimination and Bias

Banaji, Mahzarin and Anthony Greenwald. 2013. *Blindspot*, Delacorte Press.

Charlesworth, Tessa E. S. and Mahzarin R. Banaji. 2019. "Patterns of Implicit and Explicit Attitudes: I. Long-Term Change and Stability From 2007 to 2016," *Psychological Science* 30(2) 174–192.

Charlesworth, Tessa E. S. and Mahzarin R. Banaji. 2021. "Patterns of Implicit and Explicit Attitudes: III. Long-Term Change in Gender Stereotypes," *Psychological Science*, forthcoming.

Abrams, David, Marianne Bertrand, and Sendhil Mullainathan. 2012. "Do Judges Vary in Their Treatment of Race?" *Journal of Legal Studies* 41 (2): 347–83.

Bertrand, Marianne, and Sendhil Mullainathan. 2004. "Are Emily and Greg More Employable Than Lakisha and Jamal? A Field Experiment on Labor Market Discrimination." *American Economic Review* 94 (4): 991–1013.

Wolgast, Sima, Martin Bäckström, and Fredrik Björklund. 2017. "Tools for fairness: Increased structure in the selection process reduces discrimination," *PLOS ONE* 12(12): e0189512.

Eberhardt, Jennifer, Phillip Atiba Goff, Valerie J. Purdie, and Paul G. Davies. 2004. "Seeing Black: Race, Crime, and Visual Processing." *Journal of Personality and Social Psychology* 87(6): 876-893.

Edelman, Benjamin, Michael Luca, and Dan Svirsky. 2017. "Racial Discrimination in the Sharing Economy: Evidence from a Field Experiment." *American Economic Journal: Applied Economics* 9 (2): 1–22.

Glover, Dylan, Amanda Pallais, and William Pariente. 2017. "Discrimination as a Self-Fulfilling Prophecy: Evidence from French Grocery Stores." *Quarterly Journal of Economics* 132 (3): 1219-1260.

Stephens-Davidowitz, Seth. 2014. "The Cost of Racial Animus on a Black Candidate: Evidence using Google Search Data." *Journal of Public Economics* 118, 26-40.

Criminal Justice

Heller, Sara B., Anuj K. Shah, Jonathan Guryan, Jens Ludwig, Sendhil Mullainathan, Harold A. Pollack. 2020. "Thinking, Fast and Slow? Some Field Experiments to Reduce Crime and Dropout in Chicago," *Quarterly Journal of Economics*, forthcoming.

Hvistendahl, Mara. 2016. Can 'Predictive Policing' Prevent Crime Before It Happens? *Science News*.

Kleinberg, Jon, Himabindu Lakkaraju, Jure Leskovec, Jens Ludwig, and Sendhil Mullainathan. 2017. "Human Decisions and Machine Predictions." NBER Working Paper No. 23180.

James, Gareth, Daniela Witten, Trevor Hastie and Robert Tibshirani, "Tree-Based Methods," Chapter 8 in *An Introduction to Statistical Learning*.

Kleinberg, John, Jens Ludwig, and Sendhil Mullainathan. 2016. A Guide to Solving Social Problems with Machine Learning. *Harvard Business Review.*

Mohler, George, Martin Short, P. Jeffrey Brantingham, Frederick Schoenberg, and George Tita. 2011. "Self-Exciting Point Process Modeling of Crime." *Journal of the American Statistical Association* 106 (493): 100–108.

Spielkamp, Matthias. 2017. Inspecting Algorithms for Bias, MIT Tech Review.

Ludwig, Jens and Cass R. Sunstein. 2019. "Discrimination in the age of algorithms." *Boston Globe*, September 24, 2019.

Mullainathan, Sendhil. 2019. "Biased Algorithms Are Easier to Fix Than Biased People." *New York Times*, Section BU, Page 5, December 8, 2019.

Part IV: Health

Improving Health Outcomes

Allcott, Hunt, Rebecca Diamond, Jean-Pierre Dubé, Jessie Handbury, Ilya Rahkovsky, and Molly Schnell. 2019. "Food Deserts and the Causes of Nutritional Inequality," *Quarterly Journal of Economics* 134(4): 1793-1844.

Bruich, Gregory A. 2014. "The effect of SNAP benefits on household expenditures and consumption: New evidence from scanner data and the November 2013 benefit cuts." Harvard University working paper.

Chetty, Raj, Michael Stepner, Sarah Abraham, Shelby Lin, Benjamin Scuderi, Nicholas Turner, Augustin Bergeron, and David Cutler. 2016. "The Association Between Income and Life Expectancy in the United States, 2001-2014." *Journal of the American Medical Association* 315 (16): 1750–66. Non-technical summary, podcast discussion with Raj Chetty and Angus Deaton, and animated video.

Hastings, Justine and Jesse Shapiro. 2018. "How are SNAP benefits spent? Evidence from a retail panel." *American Economic Review* 108(12): 3493–3540.

Hastings, Justine, Ryan Kessler, and Jesse Shapiro. 2018. "The effect of SNAP on the composition of purchased foods: Evidence and implications." Brown University Working Paper.

Lazer, David, Ryan Kennedy, Gary King, and Alessandro Vespignani. 2014. "The Parable of Google Flu: Traps in Big Data Analysis." *Science* 343 (6167): 1203–5.

Obermeyer, Ziad and Thomas H. Lee. 2017. "Lost in thought--the limits of the human mind and the future of medicine," *New England Journal of Medicine* 377(13): 1209-1211.

Obermeyer, Ziad, Brian Powers, Christine Vogeli, and Sendhil Mullainathan. 2019. "Dissecting racial bias in an algorithm used to manage the health of populations," *Science* 366(6464): 447-453.

Pierson, Emma, David M. Cutler, Jure Leskovec, Sendhil Mullainathan, and Ziad Obermeyer. 2021. "An algorithmic approach to reducing unexplained pain disparities in underserved populations," *Nature Medicine* 27: 136-140.

The Economics of Health Care and Insurance

Baicker, Katherine, Sarah L. Taubman, Heidi L. Allen, Mira Bernstein, Jonathan H. Gruber, Joseph P. Newhouse, Eric C. Schneider, Bill J. Wright, Alan M. Zaslavsky, and Amy N. Finkelstein. 2013. "The Oregon Experiment — Effects of Medicaid on Clinical Outcomes." *New England Journal of Medicine* 368: 1713–22. Non-technical summary.

Finkelstein, Amy N., Matthew Gentzkow, and Heidi Williams. 2016. "Sources of Geographic Variation in Health Care: Evidence from Patient Migration." *Quarterly Journal of Economics* 131 (4): 1681–1726.

Finkelstein, Amy, Nathaniel Hendren, and Mark Shepard. 2019. "Subsidizing Health Insurance for Low-Income Adults: Evidence from Massachusetts," *American Economic Review* 109(4): 1530-1567. Non-technical summary

Taubman, Sarah L, Heidi L Allen, Bill J Wright, Katherine Baicker, and Amy N Finkelstein. 2014. "Medicaid Increases Emergency-Department Use: Evidence from Oregon's Health Insurance Experiment." *Science* 343 (6168): 263–68. Non-technical summary

Wherry, Laura, Sarah Miller, Robert Kaestner, and Bruce Meyer. 2018. "Childhood Medicaid Coverage and Later Life Health Care Utilization." *Review of Economics and Statistics* 100(2): 287-302.

Part V: Climate Change

Effects of Air and Water Pollution

Carleton, Tamma, and Solomon Hsiang. 2016. "Social and Economic Impacts of Climate." *Science* 353 (6304): 1112.

Dell, Melissa, Benjamin Jones, and Benjamin Olken. 2012. "Temperature Shocks and Economic Growth: Evidence from the Last Half Century." *American Economic Journal: Macroeconomics* 4(3): 66-95.

Giglio, Stefano, Matteo Maggiori, and Johannes Stroebel. 2015. "Very Long-Run Discount Rates." *Quarterly Journal of Economics* 130 (1): 1–53.

Isen, Adam, Maya Rossin-Slater, and W. Reed Walker. 2017. "Every Breath You Take - Every Dollar You'll Make: The Long-Term Consequences of the Clean Air Act of 1970." *Journal of Political Economy* 125(3): 848-909. Non-technical summary

Moore, Frances C., Nick Obradovich, Flavio Lehner, Patrick Baylis. 2019. "Rapidly Declining Remarkability of Temperature Anomalies May Obscure Public Perception of Climate Change." *Proceedings of the National Academy of Sciences,* 116(11): 4905–4910.

Moore, Frances C. and Nick Obradovich, 2020, "Using Remarkability to Define Coastal Flooding Thresholds," *Nature Communications* 11(530): 1-8.

Policies to Mitigate Climate Change

Allcott, Hunt, and Todd Rogers. 2014. "The Short-Run and Long-Run Effects of Behavioral Interventions: Experimental Evidence from Energy Conservation." *American Economic Review* 104(10): 3003–37.

Doyle, Joseph J., and Krislert Samphantharak. 2008. "$2.00 Gas! Studying the Effects of a Gas Tax Moratorium." *Journal of Public Economics* 92 (3-4): 869–84.

Gallagher, Kelly Sims, and Erich Muehlegger. 2011. "Giving Green to Get Green? Incentives and Consumer Adoption of Hybrid Vehicle Technology." *Journal of Environmental Economics and Management* 61 (1):1–15.

Ito, Koichiro. 2014. "Do Consumers Respond to Marginal or Average Price? Evidence from Nonlinear Electricity Pricing." *American Economic Review* 104 (2): 537–63.

Li, Shanjun, Joshua Linn, and Erich Muehlegger. 2014. "Gasoline Taxes and Consumer Behavior." *American Economic Journal: Economic Policy* 6 (4): 302–42

Schultz, P. Wesley, Jessica M. Nolan, Robert B. Cialdini, Noah J. Goldstein, and Vladas Griskevicius. 2007. "The Constructive, Destructive, and Reconstructive Power of Social Norms." *Psychological Science* 18 (5): 429–34.

Statistics References

Angrist, Joshua D. and Jörn-Steffen Pischke. *Mastering 'Metrics: The Path from Cause to Effect*. Princeton: Princeton University Press, 2015.

Mullainathan, Sendhil and Jan Spiess. 2017. "Machine Learning: An Applied Econometric Approach." *Journal of Economic Perspectives* 31 (2): 87-106.

Stock, James H. and Mark W. Watson. 2018. *Introduction to Econometrics*. 4th Edition. Boston: Pearson Publishers. Note: earlier editions and all international editions printed in English are acceptable.

Stata Resources

Stata 16 is available for download from FAS IT.

Stata's Base Reference Manual: http://www.stata.com/bookstore/base-reference-manual/

The Stata Blog: https://blog.stata.com/

UW-Madison SSCC: http://www.ssc.wisc.edu/sscc/pubs/sfs/home.htm