ECON 50 / HKS SUP 135 / GSE A218
Using Big Data to Solve Economic and Social Problems

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LECTURES Mondays and Wednesdays, 1:30-2:45 p.m. in Sanders Theater, 45 Quincy Street

COURSE DESCRIPTION

This course 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. Topics include equality of opportunity, education, racial disparities, innovation and entrepreneurship, health care, climate change, criminal justice, and tax policy. In the context of these topics, the course will also provide an introduction to basic methods in data science, including regression, causal inference, and machine learning. The course will include discussions with leading researchers and practitioners who use big data in real-world applications.

INSTRUCTORS

Raj Chetty is the William A. Ackman Professor of Economics at Harvard. Raj's current research, in collaboration with his Opportunity Insights research team, focuses on equality of opportunity: how can we given children from disadvantaged backgrounds the best chances of succeeding? Raj got his AB from Harvard in 2000 (where he lived in Hurlbut Hall as a first-year and then Pforzheimer House) and Ph.D. in 2003.

Gregory Bruich is a Lecturer in the Department of Economics at Harvard. He received his Ph.D. from the Department of Economics at Harvard University and his BA and BS from UC-Berkeley (where he took courses and worked with Raj). His research has focused on topics such as the impact of food stamp benefits on consumption and disability insurance on labor supply. In addition to Economics 50, he also teaches undergraduate and Ph.D.-level econometrics classes at Harvard. He is the Department of Economics' Concentration Adviser for Dunster House and Mather House.

LABS

Labs (sections), held once a week for 75 minutes, are designed to give you hands-on experience in *doing* economics yourself by working through empirical problems with your teaching fellow. Please bring your computer. There will be two types of labs:

1. No Prerequisite labs: no specific background or prior knowledge required – we're confident we'll be able to bring you up to speed!
2. Prerequisite labs: prerequisite of previous completion of one of the following: a statistics class (Stat 100, 104, 110, or equivalent) OR an econometrics class (previous or concurrent enrollment in Economics 1123/1126) OR a computer science class.

If you are unsure about which lab is better for you, please discuss with Gregory Bruich or the teaching fellows. Both labs cover the same core content and course grades *did not differ* across students in the two types of labs in last year's course; therefore, please simply enroll in the lab that matches your background without concern about its potential implications for your performance. Kennedy School students must enroll in the Prerequisite Lab.

You will be able to rank your preferences over time slots. The lab preference form will go live on Monday January 27. Please submit your preferences by **Friday 1/31 at 11:59 p.m.**

STUDENT ENGAGEMENT

Although this is a large course, we are eager to provide as personalized and hands-on a learning experience to each student as possible, through several avenues:

- **OFFICE HOURS:** For office hours with the teaching fellows, there is a Google calendar on the course website where all the regular office hours and extra office hours times and locations will be posted.

  Office hours with Dr. Bruich are 12-1 p.m. on Wednesdays in Littauer 113 and by appointment by writing to gbruich@fas.harvard.edu.

  For office hours with Professor Chetty, please email Maddie Marino <mjmarino@g.harvard.edu> with a brief description of what you'd like to discuss. Appointments will typically be scheduled between 3-4 p.m. on Wednesdays.

- **CANVAS DISCUSSION BOARD***:* We encourage you to post questions on the Canvas website and teaching fellows will respond on the site. This is valuable because other students often have the same question that you do and will benefit from seeing your interaction with your teaching fellow. Of course, feel free to email TFs directly as well if you prefer not to post your question publicly.

- **INFORMAL LUNCHES/DINNERS***:* Professor Chetty and his research team at Opportunity Insights will host a small number of lunches/dinners with 12 students each to facilitate more informal interactions. If you are interested, please sign up using a Google form available on Canvas.

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 for these projects, but students are welcome to use other programs (e.g., SAS, SPSS, R, 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.

LECTURE ATTENDANCE

In the interest of fostering interaction and discussion, students are required to attend all lectures. If you are unable to make it to a lecture because of illness (with doctor's note) or Harvard Varsity athletics travel, you may email your documentation to Dr. Bruich to request access to a recording of the lecture for a limited time (7 days from when the lecture took place). Since guest lecturers have generously offered their time to our class, student attendance will be taken when we have a guest. Students' grades will be partly based on attendance at those lectures (see below).

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. The first reading should be done in the first week. 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

Grades will be based on a midterm exam (25 percent), final exam (25 percent), four empirical projects (40 percent), lecture attendance (5 percent), and class and lab activities (5 percent). Graduating seniors who are finishing theses this semester may choose to omit the midterm and have their grade based on the final exam (50 percent), empirical projects (40 percent), lecture attendance (5 percent), and class and lab activities (5 percent). All others are required to take the midterm.

The distribution of grades in this course will be similar to other large General Education courses at Harvard.

SCHEDULE FOR EXAMS AND EMPIRICAL PROJECTS

Assignment	Due date
Project 1 part 1	11:59 p.m. on Wednesday, 2/12
Project 1 part 2	11:59 p.m. on Wednesday, 2/19
Project 2	11:59 p.m. on Wednesday, 3/4
Midterm exam	1:30-2:45 p.m. on Wednesday, 3/11
Project 3	11:59 p.m. on Wednesday, 4/8
Project 4 part 1	11:59 p.m. on Wednesday, 4/22
Project 4 part 2	11:59 p.m. on Wednesday, 4/29
Final exam	Scheduled by the FAS registrar for Tuesday, May 12 at 9:00 a.m.

PASS/FAIL: If you want to take the course pass/fail, please bring your pass/fail form to Gregory Bruich in Littauer 113.

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 5.

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. No collaboration of any kind is allowed during the midterm exam or the final exam.

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.

ACKNOWLEDGMENTS

We are grateful to many people who have contributed to the development of this course and help support it, including Amanda Bayer, Syon Bhanot, Andy Housiaux, and Rebecca Toseland as well as Abigail Hiller, Madeleine Marino, Kate Musen, Trina Ott, Federico Gonzalez-Perez, Shannon Spence, and other members of the Opportunity Insights team.

TEACHING FELLOWS AND COURSE ASSISTANTS

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CLASS SCHEDULE (as of February 23, 2020; subject to change)

Date	Num.	Topic	Selected Methods
Part I: Inequality and Social Mobility			
1/27	1	The Geography of Upward Mobility in America	correlation, regression
1/29	2	Causal Effects of Neighborhoods	experiments
1/31	3	Introductory Statistical Concepts [optional lecture, taught by Gregory Bruich and Michael Droste]	
2/3	4	Causal Effects of Neighborhoods and Characteristics of High-Mobility Areas	quasi-experiments
2/5	5	Policies to Increase Upward Mobility	
2/10	6	Historical and International Evidence on the Drivers of Inequality and Mobility	cost-benefit analysis
2/12	7	Discussion with Edward Glaeser, Professor of Economics, Harvard University	
2/17		*No class - Presidents' Day*	
2/19	8	Upward Mobility, Innovation, and Growth	propensity score reweighting
Part II: Education			
2/24	9	Higher Education and Upward Mobility	regression discontinuity
2/26	10	Primary Education	experiments
3/2	11	Teachers and Charter Schools	event study designs, competitive equilibrium
3/4	12	Discussion with Geoffrey Canada, Founder, Harlem Children's Zone	
3/9	13	Review [Bruich]	
3/11		*Midterm Exam*	
3/14-3/22		*Spring Break - no class*	
Part III: Racial Disparities & Criminal Justice			
3/23	14	Racial Disparities in Economic Opportunity	dynamic models and steady states
3/25	15	Improving Judicial Decisions	machine learning, implicit bias
3/30	16	Discussion with Mahzarin Banaji, Professor of Social Ethics, Harvard University	
4/1	17	Discussion with Jens Ludwig, Professor at the Univ. of Chicago Harris School of Public Policy	

Part IV: Health

4/6	18	Improving Health Outcomes	hazard models
4/8	19	The Economics of Health Care and Insurance	adverse selection

Part V: Climate Change

4/13	20	Effects of Air and Water Pollution and Policies to Mitigate Climate Change	diff-in-differences, externalities, discount rates, external validity
4/15	21	Discussion with Frances Moore, Professor of Environmental Science and Policy at Univ. of California, Davis	

Part VI: Tax Policy

4/20	22	Tax Policy 1: Income Taxation	supply & demand, synthetic control
4/22	23	Tax Policy 2: Savings and Wealth	behavioral economics

Part VII: Economic Development and Institutional Change

4/27	24	Discussion with Melissa Dell, Professor of Economics, Harvard University	
4/29	25	Institutions and Economic Development	historical data analysis
5/4		*No class - Reading period*	
5/6	26	Review [Bruich]	

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.

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.

Using Big Data to Measure and Understand Cities

Glaeser, Edward L., Hyunjin Kim, Michael Luca. 2019. "Nowcasting the Local Economy: Using Yelp Data to Measure Economic Activity," in Big Data for 21st Century Economic Statistics, eds. Abraham, Jarmin, Moyer, and Shapiro.

Glaeser, Edward L., Scott Duke Kominers, Michael Luca, Nikhil Naik, 2018. "Big Data and Big Cities: The Promises and Limitations of Improved Measures of Urban Life," Economic Inquiry 56(1): 114–137, January 2018.

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." Forthcoming, *Quarterly Journal of Economics* 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.

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.

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.

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.

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.

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.

Part VI: Tax Policy

Income Taxation

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Stata Resources

Stata 16 is available for download from FAS IT.

Introduction to Stata and R for Economists: https://canvas.harvard.edu/courses/19323

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