

## 15.357 — Economics of Ideas, Innovation, & Entrepreneurship

Tuesdays 6:00-9:00pm  
E62-450

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This course begins with an introduction to the economics of ideas and uses the economics of ideas to evaluate the origins of invention and discovery, innovation, entrepreneurship, and the diffusion of new technology. The focus throughout is on the microeconomic and institutional foundations for phenomena that have been studied mostly at an aggregate level. The course focuses on (a) the micro-foundations of the knowledge production function (including the role of creativity and the impact of science), (b) the impact of institutions and strategic interaction on the commercialization of new technology, and (c) the diffusion and welfare impact of ideas and technology. The course emphasizes how the unusual characteristics of ideas can result in social inefficiency, and how the microeconomic and institutional environment influences the gap between private and social welfare. The course includes a mixture (and explicit comparisons of) both theoretical and empirical research.

### Requirements:

- two group homework assignments (due October 19<sup>th</sup> and November 23<sup>rd</sup>);
- two individual “referee” reports (out of a possible seven pertaining to working papers which we have highlighted in red on the syllabus);
- Referee Reports are due by 9pm the night before the class which they are listed as part of the readings. For example, you choose to do a referee report on one of the potential referee papers from Class 2, it is due by 9pm on September 20<sup>th</sup>. To submit, please upload a copy to the course website.
- a succinct individual paper proposal, three to five pages, on a topic germane to the class, due during the last week of class (December 7<sup>th</sup>);

### Administration:

- Readings, the current version of the syllabus, assignments, and class slides are available through Canvas;

- Please contact Judith Graham-Robey [jgrobey@mit.edu] for access to Stellar or other questions about course logistics;
- There are no “official” office hours; please feel free to make appointments with Scott or Pierre individually or together.
- The class will take place in person. That said, we will launch a zoom session and share our slides, which will allow remote participants to follow along.

## Schedule at a Glance

Class 1	Ideas, Innovation, and Economic Growth	September 14	Scott
Class 2	The Nature of Ideas and Innovation	September 21	Scott
Class 3	Open Science as an Economic Institution	September 28	Pierre
Class 4	The Supply of Innovators	October 5	Pierre
Class 5	Measuring Innovation and the Impact of Innovation Policy*	October 12	Adam Jaffe
Class 6	Measuring the Returns to R&D Investments	October 19	Pierre
Class 7	Incentives for Innovators: Contracting and Control Rights	October 26	Pierre
Class 8	Incentives for Innovators: Market-level Rewards	November 2	Pierre
Class 9	The US Patent System and Innovation Policy*†	November 9	Janet Freilich
Class 10	Foundations of Entrepreneurial Strategy: Ideas and the Nature of Entrepreneurial Choice	November 16	Scott
Class 11	Foundations of Entrepreneurial Strategy: Competitive Dynamics*	November 23	Scott
Class 12	Measuring Entrepreneurship and the Impact of Entrepreneurship Policy	November 30	Scott
Class 13	The Economics of Ideas and Innovation Policy—Wrap-Up	December 7	Scott

\* these sessions will take place on zoom only.

† this session will last two hours, beginning at 7pm.

- Jones, Charles I. 2001. Chapter 4 and 5, pp. 78-86 and 96-122 in *Introduction to Economic Growth*. New York: W. W. Norton & Company.
- Varian, Hal R. 2004. "Review of Mokyr's 'Gifts of Athena'." *Journal of Economic Literature* **42**(3): 805-810.
- Nelson, Richard R. 1962. "The Link Between Science and Invention: The Case of the Transistor." In *The Rate and Direction of Inventive Activity: Economic and Social Factors*, pp. 549-583. Princeton, NJ: Princeton University Press.
- Romer, Paul M. 2018. "On the Possibility of Progress," 2018 Nobel Prize Lecture, <https://www.nobelprize.org/prizes/economic-sciences/2018/romer/lecture/>

#### *Supplementary Papers*

- Aghion, Philippe, and Peter Howitt. 1992. "A Model of Growth through Creative Destruction." *Econometrica* **60**(2): 323-351.
- Romer, Paul M. 1990. "Endogenous Technological Change." *Journal of Political Economy* **98**(5): S71-S102.
- Rosenberg, Nathan. 1979. "Technological Interdependence in the American Economy." *Technology and Culture* **20**(1): 25-50.
- Mokyr, Joel. 2005. "The Intellectual Origins of Modern Economic Growth." *Journal of Economic History* **65**(2): 285-351.
- Mokyr, Joel. 1992. *The Lever of Riches: Technological Creativity and Economic Progress*. New York: Oxford University Press.
- Rosenberg, Nathan. 1974. "Science, Invention, and Economic Growth." *Economic Journal* **84**(333): 90-108.
- Romer, Paul. 1996. "Why, Indeed, in America? Theory, History and the Origins of Modern Economic Growth." *American Economic Review* **86**(2): 202-206.
- Jones, Charles I. 2021. "The Past and Future of Economic Growth: A Semi-Endogenous Perspective." NBER Working Paper #29126.

*Required Readings*

- Arrow, Kenneth. 1962. "Economic Welfare and the Allocation of Resources for Invention." In *The Rate and Direction of Inventive Activity: Economic and Social Factors*, pp. 609-625. Princeton, NJ: Princeton University Press.
- Jones, Charles I. 1999. "Growth: With or Without Scale Effects?" *American Economic Review* **89**(2): 139-144.
- Jones, Benjamin F. 2009. "The Burden of Knowledge and the 'Death of the Renaissance Man': Is Innovation Getting Harder?" *Review of Economic Studies* **76**(1): 283-317.
- Wuchty, Stefan, Benjamin F. Jones, and Brian Uzzi. 2007. "The Increasing Dominance of Teams in Production of Knowledge." *Science* **316**(5827): 1036-1039.
- Jones, Benjamin F. 2010. "Age and Great Invention." *Review of Economics and Statistics* **92**(1): 1-14.
- Bresnahan, Timothy F., and Manuel Trajtenberg. 1995. "General Purpose Technologies: Engines of Growth?" *Journal of Econometrics* **65**(1): 83-108.
- Bloom, Nicholas, Charles I. Jones, John Van Reenen, and Michael Webb. 2020. "Are Ideas Getting Harder to Find?" *American Economic Review* **110**(4): 1104-1144.

*Potential Referee Reports*

- Bhaskarabhatla, Ajay, Luis Cabral, Deepak Hegde, and Thomas Peeters. 2021. "Are Inventors or Firms the Engines of Innovation?" Working Paper, New York University.**

*Supplementary Papers*

- Agrawal, Ajay, Avi Goldfarb, and Florenta Teodoridis. 2016. "Understanding the Changing Structure of Scientific Inquiry." *American Economic Journal: Applied Economics* **8**(1): 100-128.
- David, Paul. 1990. "The Dynamo and the Computer: An Historical Perspective on the Modern Productivity Paradox." *American Economic Review* **80**(2): 355-361.
- Foray, Dominique. 2004. *Economics of Knowledge*. Cambridge, MA: MIT Press.
- Henderson, Rebecca, and Kim Clark. 1990. "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms." *Administrative Science Quarterly* **35**(1): 9-30.
- Kortum, Samuel. 1997. "Research, Patenting, and Technological Change." *Econometrica* **65**(6): 1389-1419.
- Murray, Fiona. 2002. "Innovation as Co-Evolution of Scientific and Technological Networks: Exploring Tissue Engineering." *Research Policy* **31**(8-9): 1389-1403.
- Ó Gráda, Cormac. 2016. "Did Science Cause the Industrial Revolution?" *Journal of Economic Literature* **54**(1): 224-239.
- Nelson, Richard R. 1959. "The Simple Economics of Basic Scientific Research." *Journal of Political Economy* **67**(2): 297-306.
- Rosenberg, Nathan, and Manuel Trajtenberg. 2004. "A General-Purpose Technology at Work: The Corliss Steam Engine in the Late-Nineteenth-Century United States." *Journal of Economic History* **64**(1): 61-99.
- Stokes, Donald. 1997. *Pasteur's Quadrant: Basic Science and Technological Innovation*. Washington, DC: Brookings Institution Press.
- Weitzman, Martin L. 1998. "Recombinant Growth." *Quarterly Journal of Economics* **113**(2): 331-360.

*Required Readings*

- Aghion, Philippe, Mathias Dewatripont, and Jeremy C. Stein. 2008. "Academic Freedom, Private Sector Focus, and the Process of Innovation." *RAND Journal of Economics* 39(3): 617-635.
- Azoulay, Pierre, Toby Stuart, and Yanbo Wang. 2014. "Matthew: Effect or Fable?" *Management Science* 60(1): 92-109.
- Azoulay, Pierre, Christian Fons-Rosen, and Joshua S. Graff Zivin. 2019. "Does Science Advance One Funeral at a Time?" *American Economic Review* 109(8): 2889-2920.
- Bikard, Michaël. 2018. "Made in Academia: The Effect of Institutional Origin on Inventors' Attention to Science." *Organization Science*, 29 (5):818-36
- Dasgupta, Partha, and David. Paul. 1994. "Towards a New Economics of Science." *Research Policy* 23(5): 487-521.
- Fleming, Lee, and Olav Sorenson. 2004. "Science as a Map in Technological Search." *Strategic Management Journal* 25(8-9): 909-928.
- Merton, Robert K. 1957. "Priorities in Scientific Discovery: A Chapter in the Sociology of Science." *American Sociological Review* 22(6): 635-659.
- Merton, Robert K. 1968. "The Matthew Effect in Science." *Science* 159(3810): 56-63.
- Murray, Fiona, Philippe Aghion, Mathias Dewatripont, Julian Kolev, and Scott Stern. 2016. "Of Mice and Academics: Examining the Effect of Openness on Innovation." *American Economic Journal: Economic Policy* 8(1): 212-252.
- Stern, Scott. 2004. "Do Scientists Pay to Be Scientists?" *Management Science* 50(6): 835-853.
- Myers, Kyle. 2020. "The Elasticity of Science." *American Economic Journal: Applied Economics* 12(4): 103-134.
- Furman, Jeffrey, and Scott Stern. 2011. "Climbing Atop the Shoulders of Giants: The Impact of Institutions on Cumulative Knowledge Production." *American Economic Review* 101(5): 1933-1963.

**Broad Surveys**

- (\*)Dasgupta, Partha, and David. Paul. 1994. "Towards a New Economics of Science." *Research Policy* 23(5): 487-521.
- Stephan, Paula. 2013. "The Endless Frontier: Reaping What Bush Sowed?" NBER Working Paper #19687.
- Stephan, Paula E. 2010. "The Economics of Science." In Bronwyn H. Hall, and Nathan Rosenberg (Eds.), *Handbook of The Economics of Innovation*, pp. 217-273. Amsterdam: North-Holland.
- Nelson, Richard R. 2016. "The Sciences Are Different and the Differences Matter." *Research Policy* 45(9): 1692-1701.
- Hess, David J. 1997. *Science Studies: An Advanced Introduction*. New York: NYU Press.
- Varmus, Harold. 2009. *The Art and Politics of Science*. New York: W. W. Norton & Company.

**What is Science?**

- Brooks, Harvey. 1994. "The Relationship Between Science and Technology." *Research Policy* 23(5): 477-486.
- Gieryn, Thomas F. 1983. "Boundary-work and the Demarcation of Science from Non-science: Strains and Interests in Professional Ideologies of Scientists." *American Sociological Review* 48(6): 781-795.
- Stokes, Donald. 1997. *Pasteur's Quadrant: Basic Science and Technological Innovation*. Washington, DC: Brookings Institution Press.
- Murray, Fiona. 2010. "The Oncomouse that Roared: Hybrid Exchange Strategies as a Source of Productive Tension at the Boundary of Overlapping Institutions." *American Journal of Sociology* 116(2): 341-388.
- Balconi, Margherita, Stefano Brusoni, and Luigi Orsenigo. 2010. "In Defence of the Linear Model: An Essay." *Research Policy* 39(1): 1-13.

### Science as a Social Institution

- (\*)Dasgupta, Partha, and David. Paul. 1994. "Towards a New Economics of Science." *Research Policy* **23**(5): 487-521.
- (\*)Merton, Robert K. 1957. "Priorities in Scientific Discovery: A Chapter in the Sociology of Science." *American Sociological Review* **22**(6): 635-659.
- (\*)Merton, Robert K. 1968. "The Matthew Effect in Science." *Science* **159**(3810): 56-63.
- (\*)Azoulay, Pierre, Toby Stuart, and Yanbo Wang. 2014. "Matthew: Effect or Fable?" *Management Science* **60**(1): 92-109.
- (\*)Stern, Scott. 2004. "Do Scientists Pay to Be Scientists?" *Management Science* **50**(6): 835-853.
- Merton, Robert K. 1973. *The Sociology of Science: Theoretical and Empirical Investigation*. Chicago, IL: University of Chicago Press.
- Nagaoka, Sadao, and Hideo Owan. 2014. "Author Ordering in Scientific Research: Evidence from Scientists Survey in the US and Japan." IIR Working Paper #13-23, Hitotsubashi University, Institute of Innovation Research.
- Zuckerman, Harriet A. 1968. "Patterns of Name Ordering Among Authors of Scientific Papers: A Study of Social Symbolism and Its Ambiguity." *American Journal of Sociology* **74**(3): 276-291.
- Gans, Joshua S., and Fiona Murray. 2013. "Credit History: The Changing Nature of Scientific Credit." NBER Working Paper #19538.
- Leahey, Erin, Christine M. Beckman, and Taryn L. Stanko. 2017. "Prominent but Less Productive: The Impact of Interdisciplinarity on Scientists' Research." *Administrative Science Quarterly* **62**(1): 105-139.
- Bourdieu, Pierre. 1975. "La Spécificité du Champ Scientifique et les Conditions Sociales du Progrès de la Raison." *Sociologie et Sociétés* **7**(1): 91-118.
- Bourdieu, Pierre. 1991. "The Peculiar History of Scientific Reason." *Sociological Forum* **6**(1): 3-26.
- Latour, Bruno, and Steven Woolgar. 1979. *Laboratory Life*. Beverly Hills, CA: Sage Publications.
- Owen-Smith, Jason. 2001. "Managing Laboratory Work Through Skepticism: Processes of Evaluation and Control." *American Sociological Review* **66**(3): 427-452.

### The Direction of Science

- Kuhn, Thomas S. 1962. *The Structure of Scientific Revolutions*. Chicago, IL: University of Chicago Press.
- (\*)Azoulay, Pierre, Christian Fons-Rosen, and Joshua S. Graff Zivin. 2019. "Does Science Advance One Funeral at a Time?" *American Economic Review* **109**(8): 2889-2920.
- (\*)Myers, Kyle. 2020. "The Elasticity of Science." *American Economic Journal: Applied Economics* **12**(4): 103-134.
- Rosenberg, Nathan. 1982. "How Exogenous is Science?" In *Inside the Black Box*, pp. 141-158. New York: Cambridge University Press.
- Hopenhayn, Hugo, and Francesco Squintani. 2021. "On the Direction of Innovation." *Journal of Political Economy* **129**(7): 1991-2022.
- Bramoullé, Yann, and Gilles Saint-Paul. 2010. "Research Cycles." *Journal of Economic Theory* **145**(5): 1890-1920.
- McMahan, Peter, and Daniel A. McFarland. 2021. "Creative Destruction: The Structural Consequences of Scientific Curation." *American Sociological Review* **86**(2): 341-76.
- Akerlof, George, and Pascal Michaillat. 2017. "Beetles: Biased Promotion and Persistence of False Belief." NBER Working Paper #23523.
- Rubin, Amir, and Eran Rubin. 2021. "Systematic Bias in the Progress of Research." *Journal of Political Economy* **129**(9): 2066-719.

### Scientific Competition

- Wade, Nicholas. 1981. *The Nobel Duel: Two Scientists' 21-year Race to Win the World's Most Coveted Research Prize*. Garden City, NY: Anchor Press/Doubleday.
- Bobtcheff, Catherine, Jérôme Bolte, and Thomas Mariotti. 2017. "Researcher's Dilemma." *The Review of Economic Studies*, **84**(3): 969-1014.
- Werth, Barry. 1995. *The Billion Dollar Molecule: One Company's Quest for the Perfect Drug*. New York: Simon & Schuster.

### Potential Referee Reports

- Hill, Ryan, and Carolyn Stein. 2021. "Race to the Bottom: Competition and Quality in Science." Working Paper, MIT.
- Hill, Ryan, and Carolyn Stein. 2021. "Scooped! Estimating Rewards for Priority in Science." Working Paper, MIT.

### Science and its Institutions

- (\*)Furman, Jeffrey, and Scott Stern. 2011. "Climbing Atop the Shoulders of Giants: The Impact of Institutions on Cumulative Knowledge Production." *American Economic Review* **101**(5): 1933-1963.
- Andrews, Michael. Forthcoming. "How Do Institutions of Higher Education Affect Local Invention? Evidence from the Establishment of U.S. Colleges." *American Economic Journal: Economic Policy*.
- Li, Danielle. 2017. "Expertise vs. Bias in Evaluation: Evidence from the NIH." *American Economic Journal: Applied Economics* **9**(2): 60-92.
- Boudreau, Kevin J., Eva C. Guinan, Karim R. Lakhani, and Christoph Riedl. 2016. "Looking Across and Looking Beyond the Knowledge Frontier: Intellectual Distance, Novelty, and Resource Allocation in Science." *Management Science* **62**(10): 2765-2783.
- Gentil-Beccot, Anne, Salvatore Mele, and Travis C. Brooks. 2009. "Citing and Reading Behaviours in High-Energy Physics: How a Community Stopped Worrying about Journals and Learned to Love Repositories." Working Paper, CERN, arXiv:0906.5418.
- Furman, Jeffrey L., Kyle Jensen, and Fiona Murray. 2012. "Governing Knowledge in the Scientific Community: Exploring the Role of Retractions in Biomedicine." *Research Policy* **41**(2): 276-290.
- Card, David, and Stefano Della Vigna. 2020. "What Do Editors Maximize? Evidence from Four Leading Economics Journals." *The Review of Economics and Statistics* **102**(1): 195-217.
- Waldinger, Fabian. 2016. "Bombs, Brains, and Science: The Role of Human and Physical Capital for the Creation of Scientific Knowledge." *Review of Economics and Statistics* **98**(5): 811-831.
- Helmers, Christian, and Henry G. Overman. 2017. "My Precious! The Location and Diffusion of Scientific Research: Evidence from the Synchrotron Diamond Light Source." *The Economic Journal* **127**(604): 2006-2040.

### The Relationship Between Science and Technology

- (\*)Aghion, Philippe, Mathias Dewatripont, and Jeremy C. Stein. 2008. "Academic Freedom, Private Sector Focus, and the Process of Innovation." *RAND Journal of Economics* **39**(3): 617-635.
- (\*)Fleming, Lee, and Olav Sorenson. 2004. "Science as a Map in Technological Search." *Strategic Management Journal* **25**(8-9): 909-928.
- (\*)Murray, Fiona, Philippe Aghion, Mathias Dewatripont, Julian Kolev, and Scott Stern. 2016. "Of Mice and Academics: Examining the Effect of Openness on Innovation." *American Economic Journal: Economic Policy* **8**(1): 212-252.
- (\*)Bikard, Michaël. 2018. "Made in Academia: The Effect of Institutional Origin on Inventors' Attention to Science." *Organization Science* **29**(5): 818-36



- Murray, Fiona and Scott Stern. 2007. "Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge?: An Empirical Test of the Anti-Commons Hypothesis." *Journal of Economic Behavior and Organization* **63**(4): 648-487.
- Rosenberg, Nathan, and Richard R. Nelson. 1994. "American Universities and Technical Advance in Industry." *Research Policy* **23**(3): 323-348.
- Ahmadpoor, Mohammad, and Benjamin F. Jones. 2007. "The Dual Frontier: Patented Inventions and Prior Scientific Advance." *Science* **357**(6531): 583-587.
- Azoulay, Pierre, Christopher C. Liu, and Toby Stuart. 2017. "Social Influence Given (Partially) Deliberate Matching: Career Imprints in the Creation of Academic Entrepreneurs." *American Journal of Sociology* **122**(4): 1223-1271.

### **Science in the Private Sector**

- Rosenberg, Nathan. 1990. "Why Do Firms Do Basic Research (with their own money)?" *Research Policy* **19**(2): 165-174.
- Sauermann, Henry, and Michael Roach. 2014. "Not All Scientists Pay to Be Scientists: PhDs' Preferences for Publishing in Industrial Employment." *Research Policy* **43**(1): 32-47.
- Arora, Ashish, Sharon Belenzon, Konstantin Kosenko, Jungkyu Suh, and Yishay Yafeh. 2021. "The Rise of Scientific Research in Corporate America." NBER Working Paper #29260.
- Arora, Ashish, Belenzon, Sharon, and Andrea Pataconi. "Killing the Golden Goose? The Decline of Science in Corporate R&D." NBER Working Paper #20902.

Class 4

## The Supply of Innovators

October 5

### *Required Readings*

- Bell, Alexander M., 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): 647-713.
- Shu, Pian. 2015. "Are the 'Best and Brightest' Going into Finance? Career Choice and Skill Development of MIT Graduates." Harvard Business School Working Paper #16-067.
- Borjas, George J., and Kirk B. Doran. 2012. "The Collapse of the Soviet Union and the Productivity of American Mathematicians." *Quarterly Journal of Economics*, **127**(3): 1143-1203.
- Moser, Petra, Alessandra Voena, and Fabian Waldinger. 2014. "German-Jewish Emigrés and US Invention." *American Economic Review* **104**(10): 3222-3255.
- Deming, David J., and Kadeem L. Noray. 2020. "Earnings Dynamics, Changing Job Skills, and STEM Careers." *Quarterly Journal of Economics* **135**(4): 1965-2005.
- Azoulay, Pierre, Wesley H. Greenblatt, and Misty L. Heggeness. 2021. "Long-Term Effects from Early Exposure to Research: Evidence from the NIH 'Yellow Berets'." *Research Policy* **50**(9): 104332.
- Agarwal, Ruchir, and Patrick Gaulé. 2020. "Invisible Geniuses: Could the Knowledge Frontier Advance Faster?" *American Economic Review: Insights* **2**(4): 409-424.
- Ahmadpoor, Mohammad, and Benjamin F. Jones. 2019. "Decoding Teams and Individual Impact in Science and Invention." *Proceedings of the National Academy of Sciences* **116**(28): 13885-13890.
- Biasi, Barbara, David J. Deming, and Petra Moser. 2021. "Education and Innovation." NBER Working Paper #28544.

### *Potential Referee Reports*

- Boudreau, Kevin J., and Matt Marx. 2019. "Field Experimental Evidence on Early Exposure of Engineering Majors to Professional Work." NBER Working Paper #26013.
- Aghion, Philippe, Ufuk Akcigit, Ari Hyytinen, and Otto Toivanen. 2017. "The Social Origins of Inventors." NBER Working Paper #24110.
- Ganguli, Ina, Patrick Gaulé, and Danijela Vuletić Čugalj. 2021. "Biased Beliefs and Entry into Scientific Careers." Working Paper, UMASS Amherst.
- Biasi, Barbara, and Song Ma. 2021. "The Education-Innovation Gap." Working Paper, Yale School of Management.

### *Supplementary Papers*

#### **Who is (or Who Becomes) an Innovator?**

- Bell, Alexander M., Raj Chetty, Xavier Jaravel, Neviana Petkova, and John Van Reenen. 2019. "Do Tax Cuts Produce More Einsteins? The Impacts of Financial Incentives versus Exposure to Innovation on the Supply of Inventors." *Journal of the European Economic Association* 17(3): 651-677.
- Shu, Pian. 2012. "The Long-Term Impact of Business Cycles on Innovation: Evidence from the Massachusetts Institute of Technology." Working Paper, Massachusetts Institute of Technology.
- Stephan, Paula E. 2012. *How Economics Shapes Science*. Cambridge, MA: Harvard University Press. Chapter 7 ("The Market for Scientists and Engineers").
- Ellison, Glenn, and Ashley Swanson. 2016. "Do Schools Matter for High Math Achievement? Evidence from the American Mathematics Competitions." *American Economic Review* 106(6): 1244-1277.
- Toivanen, Otto, and Lotta Väänänen. 2016. "Education and Invention." *Review of Economics and Statistics* 98(2): 382-396.
- Aghion, Philippe, Ufuk Akcigit, Antonin Bergeaud, Richard Blundell, and David Hémous. 2019. "Innovation and Top Income Inequality." *Review of Economic Studies* 86(1): 1-45.
- Jones, Benjamin F., and Bruce A. Weinberg. 2011. "Age Dynamics in Scientific Creativity." *Proceedings of the National Academy of Sciences* 108(47): 18910-18914.
- Levin, Sharon G., and Paula E. Stephan. 1991. "Research Productivity over the Life Cycle: Evidence for Academic Scientists." *American Economic Review* 81(1): 114-32.

#### **Immigration**

- Hunt, Jennifer, and Marjolaine Gauthier-Loiselle. 2010. "How Much Does Immigration Boost Innovation?" *American Economic Journal: Macroeconomics* 2(2): 31-56.
- Kerr, William R., and William F. Lincoln. 2010. "The Supply Side of Innovation: H-1B Visa Reforms and U.S. Ethnic Invention." *Journal of Labor Economics* 28(3): 473-508.
- Stephan, Paula E. 2012. *How Economics Shapes Science*. Cambridge, MA: Harvard University Press. Chapter 8 ("The Foreign Born").
- Franzoni, Chiara, Giuseppe Scellato, and Paula Stephan. 2015. "International Mobility of Research Scientists: Lessons from GlobSci." In Aldo Geuna (Ed.), *Global Mobility of Research Scientists: The Economics of Who Goes Where and Why*, pp. 35-65. Amsterdam: Elsevier.
- Ganguli, Ina. 2015. "Who Leaves and Who Stays? Evidence on Immigrant Selection from the Collapse of Soviet Science." In Aldo Geuna (Ed.), *Global Mobility of Research Scientists: The Economics of Who Goes Where and Why*, pp. 133-154. Amsterdam: Elsevier.
- Gaulé, Patrick, and Mario Piacentini. 2013. "Chinese Graduate Students and U.S. Scientific Productivity." *Review of Economics and Statistics* 95(2): 698-701.

- Borjas, George J., Kirk B. Doran, and Ying Shen. 2018. "Ethnic Complementarities After the Opening of China: How Chinese Graduate Students Affected the Productivity of their Advisors." *Journal of Human Resources* 53(1): 1-31.
- Kahn, Shulamit and Megan J. MacGarvie. 2016. "How Important is U.S. Location for Research in Science?" *Review of Economics and Statistics*, 98(2): 397-414.

### **Superstars, Concavity and the Concatenation of Talent**

- Cole, Jonathan R., and Stephen Cole. 1972. "The Ortega Hypothesis." *Science* 178(4059): 368-375.
- Azoulay, Pierre, Joshua Graff Zivin, and Jialan Wang. 2010. "Superstar Extinction." *Quarterly Journal of Economics* 125(2): 549-589.
- Waldinger, Fabian. 2012. "Peer Effects in Science: Evidence from the Dismissal of Scientists in Nazi Germany." *Review of Economic Studies* 79(2): 838-861.
- Zucker, Lynne G., Michael R. Darby, and Marilyn B. Brewer. 1998. "Intellectual Human Capital and the Birth of U.S. Biotechnology Enterprises." *American Economic Review* 88(1): 290-306.
- Teodoridis, Florenta. 2018. "Understanding Team Knowledge Production: The Interrelated Roles of Technology and Expertise." *Management Science* 64(8): 3469-3970.

### **Discrimination and Stratification**

- Ding, Waverly W., Fiona Murray, and Toby E. Stuart. 2013. "From Bench to Board: Gender Differences in University Scientists' Participation in Corporate Scientific Advisory Boards." *Academy of Management Journal* 56(5): 1443-1464.
- Arcidiacono, Peter, Esteban Aucejo, and V. Joseph Hotz. 2016. "University Differences in the Graduation of Minorities in STEM Fields: Evidence from California." *American Economic Review* 106(3): 525-562.
- Blau, Francine D., Janet M. Currie, Rachel T.A. Croson, and Donna K. Ginther. 2010. "Can Mentoring Help Female Assistant Professors? Interim Results from a Randomized Trial." *American Economic Review: Papers & Proceedings* 100(2): 348-352.
- Breda, Thomas, and Son Thierry Ly. 2015. "Professors in Core Science Fields Are Not Always Biased against Women: Evidence from France." *American Economic Journal: Applied Economics* 7(4): 53-75.
- Brooks, Alison Wood, Laura Huang, Sarah Wood Kearney, and Fiona E. Murray. 2014. "Investors Prefer Entrepreneurial Ventures Pitched by Attractive Men." *Proceedings of the National Academy of Sciences* 111(12): 4427-4431.
- Kahn, Shulamit, and Donna K. Ginther. 2017. "Women and STEM." NBER Working Paper #23525.
- Ginther, Donna K., Walter T. Schaffer, Joshua Schnell, Beth Masimore, Faye Liu, Laurel L. Haak, and Raynard Kington. 2011. "Race, Ethnicity, and NIH Research Awards." *Science* 333(6045): 1015-1019.
- Zinovyeva, Natalia, and Manuel Bagues. 2015. "The Role of Connections in Academic Promotions." *American Economic Journal: Applied Economics* 7(2): 264-292.
- Bagues, Manuel, Manuel Sylos-Labini, and Natalia Zinovyeva. 2017. "Does the Gender Composition of Scientific Committees Matter?" *American Economic Review* 107(4): 1207-1238.
- Lambrecht, Anja, and Catherine E. Tucker. 2019. "Algorithmic Bias? An Empirical Study into Apparent Gender-Based Discrimination in the Display of STEM Career Ads." *Management Science* 65(7): 2966-2981.

### **Manpower Analysis' Sad Track Record**

- Goolsbee, Austan. 1998. "Does R&D Policy Primarily Benefit Scientists and Engineers?" *American Economic Review* 88(2): 298-302.

- Romer, Paul M. 2000. "Should the Government Subsidize Supply or Demand in the Market for Scientists and Engineers?" *Innovation Policy and the Economy* 1: 221-252.
- Freeman, Richard, and John van Reenen. 2009. "What if Congress Doubled R&D Spending on the Physical Sciences?" *Innovation Policy and the Economy* 9: 1-38.
- Freeman, Richard B. 1975. "Supply and Salary Adjustments to the Changing Science Manpower Market: Physics, 1948-1973." *American Economic Review* 65(1): 27-39.
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Class 5      Measuring Innovation and the Impact of Innovation  
Policy and Institutions, Guest Lecture by Adam Jaffe

October 12

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## Class 8 Incentives for Innovators: Market-Level Rewards

November 2

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