

15.357 – Economics of Ideas, Innovation, & Entrepreneurship

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

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Professor Scott Stern	sstern@mit.edu	E62-476

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 6th and November 24th);
- two individual “referee” reports (out of a possible seven pertaining to working papers which we have highlighted in red on the syllabus);
- a succinct individual paper proposal, three to five pages, on a topic germane to the class, due on the last day of class (December 1st);

Administration:

- readings, the current version of the syllabus, assignments, and class slides are available through Stellar;
- please contact Tetyana Pecherska, tetyana@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.

Schedule at a Glance

Class 1	Ideas, Innovation, and Economic Growth	September 15	Scott
Class 2	The Nature of Ideas and Innovation	September 22	Scott
Class 3	The Supply of Innovators	September 29	Pierre
Class 4	Incentives for Innovators: Contracting and Control Rights	October 6	Pierre
Class 5	Incentives for Innovators: Market-level Rewards	October 13	Pierre
Class 6	GUEST LECTURE: The Life Cycle of Inventors	October 20	Raj Chetty
Class 7	Open Science as an Economic Institution	October 27	Scott
Class 8	Strategic Interaction in Cumulative Innovation Environments	November 2*	Scott
Class 9	Entrepreneurial Strategy	November 10	Scott
Class 10	GUEST LECTURE: Markets for Technology	November 17	Alfonso G.
Class 11	The Measurement of Innovation	November 24	Pierre
Class 12	The Measurement of Entrepreneurial Ecosystems	December 1	Scott

*Note the odd (and exceptional) timing for this session: Monday, 6-9pm instead of Tuesday at the same time.

- (*) Jones, Charles I. 2001. Chapter 4 and 5, pp. 78-86 and 96-122 in *Introduction to Economic Growth*. New York: 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. 1990. "Endogenous Technological Change." *Journal of Political Economy* **98**(5): S71-S102.
- Aghion, Philippe, and Peter Howitt. 1992. "A Model of Growth through Creative Destruction." *Econometrica* **60**(2): 323-351.
- 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.
- Romer, Paul. 1996. "Why, Indeed, in America? Theory, History and the Origins of Modern Economic Growth." *American Economic Review* **86**(2): 202-206.

- (*) 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. **READ pp. 609-618 ONLY.**
- (*) 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.
- Agrawal, Ajay K., Avi Goldfarb, and Florenta Teodoridis. 2014. "Does Knowledge Accumulation Increase the Returns to Collaboration?" *American Economic Journal: Applied Economics*, Forthcoming.
- Brooks, Harvey. 1994. "The Relationship Between Science and Technology." *Research Policy* **23**(5): 477-486.
- Athey, Susan, and Armin Schmutzler. 1995. "Product and Process Flexibility in an Innovative Environment." *RAND Journal of Economics* **26**(4): 557-574.
- Irwin, Douglas A., and Peter J. Klenow. 1996. "High-Tech R&D Subsidies: Estimating the Effects of Sematech." *Journal of International Economics* **40**(3-4): 323-344.
- 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.

- 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.
- Jovanovic, Boyan, and Peter L. Rousseau. 2005. "General Purpose Technologies." In Philippe Aghion, and Steven N. Durlauf (Eds.), *Handbook of Economic Growth*, pp. 1181-1224. Amsterdam: North-Holland.
- Murray, Fiona. 2002. "Innovation as Co-Evolution of Scientific and Technological Networks: Exploring Tissue Engineering." *Research Policy* **31**(8-9): 1389-1403.
- Stokes, Donald. 1997. *Pasteur's Quadrant: Basic Science and Technological Innovation*. Washington, DC: Brookings Institution Press.
- Kortum, Samuel. 1997. "Research, Patenting, and Technological Change." *Econometrica* **65**(6): 1389-1419.
- Weitzman, Martin L. 1998. "Recombinant Growth." *Quarterly Journal of Economics* **113**(2): 331-360.

Class 3

The Supply of Innovators

September 39

Who Is (or Who becomes) an Innovator?

- 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.
- (*) Shu, Pian. 2013. "Are the 'Best and Brightest' Going into Finance? Career Choice and Skill Development of MIT Graduates." Working Paper, Harvard University.
- Stephan, Paula E. 2012. *How Economics Shapes Science*. Cambridge, MA: Harvard University Press. Chapter 7 ("The Market for Scientists and Engineers").
- 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.
- Toivanen, Otto, and Lotta Väänänen. 2016. "Education and Invention." *Review of Economics and Statistics* **98**(1): xxx-xxx.

Immigration

- Hunt, Jennifer, and Marjolaine Gauthier-Loiselle. 2010. "How Much Does Immigration Boost Innovation?" *American Economic Journal: Macroeconomics* **2**(2): 31-56.
- (*) 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.
- 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.
- Kahn, Shulamit and Megan J. MacGarvie. 2015. "How Important is U.S. Location for Research in Science?" *Review of Economics and Statistics*, Forthcoming.

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.

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. 2015. "University Differences in the Graduation of Minorities in STEM Fields: Evidence from California." *American Economic Review* **105**(12): xxx-xxx.
- 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.
- 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.

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.

- Freeman, Richard B., Tanwin Chang, and Hanley Chiang. 2005. "Supporting the 'Best and Brightest' in Science and Engineering: NSF Graduate Research Fellowships." NBER Working Paper #11623.
- Teitelbaum, Michael S. 2014. *Falling Behind? Boom, Bust and the Global Race for Scientific Talent*. Princeton, NJ: Princeton University Press.
- Ehrenberg, Ronald G. 1992. "The Flow of New Doctorates." *Journal of Economic Literature* **30**(2): 830-875.
- Committee on Science, Engineering, and Public Policy (COSEPUP). 2006. *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. Washington, D.C.: National Academies Press.

Class 4 Incentives for Innovators: Contracts and Control Rights

October 6

- (*) Manso, Gustavo. 2011. "Motivating Innovation." *Journal of Finance* **66**(5): 1823-1860.
- (*) Azoulay, Pierre, Joshua Graff Zivin, and Gustavo Manso. 2011. "Incentives and Creativity: Evidence from the Academic Life Sciences." *RAND Journal of Economics* **42**(3): 527-554.
- (*) Aghion, Philippe, and Jean Tirole. 1994. "The Management of Innovation." *Quarterly Journal of Economics* **109**(4): 1185-1209.
- (*) Lerner, Joshua, and Ulrike Malmendier. 2010. "Contractibility and the Design of Research Agreements." *American Economic Review* **100**(1): 214-246.
- Tian, Xuan, and Tracy Yue Wang. 2014. "Tolerance for Failure and Corporate Innovation." *Review of Financial Studies* **27**(1): 211-255.
- Hellmann, Thomas, and Veikko Thielez. 2011. "Incentives and Innovation: A Multi-tasking Approach." *American Economic Journal: Microeconomics* **3**(1): 78-128.
- Holmstrom, Bengt. 1989. "Agency Costs and Innovation." *Journal of Economic Behavior and Organization* **12**(3): 305-327.
- Lazear, Edward P. 1997. "Incentives in Basic Research." *Journal of Labor Economics* **15**(1): S167-S197.
- Lerner, Joshua, and Julie Wulf. 2007. "Innovation and Incentives: Evidence from Corporate R&D." *Review of Economics and Statistics* **89**(4): 634-644.
- Boudreau, Kevin J., and Karim R. Lakhani. 2012. "The Confederacy of Heterogeneous Software Organizations and Heterogeneous Developers: Field Experimental Evidence on Sorting and Worker Effort." Chapter 10 in *The Rate & Direction of Inventive Activity Revisited* (edited by Joshua Lerner and Scott Stern), pp. 483-502, 2012.
- Ederer, Florian. 2013. "Incentives for Parallel Innovation." Working Paper, Yale School of Management. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2309664.
- Novak, Sharon, and Scott Stern. 2008. "How Does Outsourcing Affect Performance Dynamics? Evidence from the Automobile Industry." *Management Science* **54**(12): 1963-1979.
- Carmichael, H. Lorne. 1988. "Incentives in Academics: Why Is There Tenure?" *Journal of Political Economy* **96**(3): 453-472.
- Siow, Aloysius. 1998. "Tenure and other Unusual Personnel Practices in Academia." *Journal of Law, Economics and Organization* **14**(1): 152-173.
- Hörner, Johannes, and Larry Samuelson. 2013. "Incentives for Experimenting Agents." *RAND Journal of Economics* **44**(4): 632-663.
- Feynman, Richard P. 1999. *The Pleasure of Finding Things Out*. New York: Basic Books.

PROBLEM SET #1 DUE!

- (*) Gallini, Nancy, and Suzanne Scotchmer. 2002. "Intellectual Property: What is the Best Incentive System." *Innovation Policy and the Economy* 2: 51-77.
- (*) Wright, Brian. 1983. "The Economics of Invention Incentives: Patents, Prizes, and Research Contracts." *American Economic Review* 73(4): 691-707.
- Williams, Heidi L. 2013. "Intellectual Property Rights and Innovation: Evidence from the Human Genome." *Journal of Political Economy* 121(1): 1-27.
- (*) Moser, Petra. 2013. "Patents and Innovation: Evidence from Economic History." *Journal of Economic Perspectives* 27(1): 23-44.
- Weyl, E. Glen, and Jean Tirole. 2013. "Market Power Screens Willingness-to-Pay." *Quarterly Journal of Economics* 127(4): 1971-2003.
- Shavell, Steven, and Tanguy van Ypersele. 2001. "Rewards versus Intellectual Property Rights." *Journal of Law and Economics* 44(2): 525-547.
- Kremer, Michael. 1998. "Patent Buyouts: A Mechanism for Encouraging Innovation." *Quarterly Journal of Economics* 113(4): 1137-1167.
- Kremer, Michael, and Christopher M. Snyder. 2015. "Preventives Versus Treatment." *Quarterly Journal of Economics* 130(3): 1167-1239.
- Boldrin, Michele, and David Levine. 2002. "The Case Against Intellectual Property." *American Economic Association Papers & Proceedings* 92(2): 209-212.

Prizes and Prize Design

- (*) Brunt, Liam, Josh Lerner, and Tom Nicholas. 2012. "Inducement Prizes and Innovation." *Journal of Industrial Economics* 45(4): 657-696.
- Che, Yeon-Koo, and Ian Gale. 2003. "Optimal Design of Research Contests." *American Economic Review* 93(3): 646-671.
- Khan, B. Zorina. 2015. "Inventing Prizes: An Historical Perspective on Innovation Awards and Technology Policy." NBER Working Paper #21375.
- Moser, Petra, and Tom Nicholas. 2013. "Prizes, Publicity, And Patents: Non-Monetary Awards As A Mechanism To Encourage Innovation." *Journal of Industrial Economics* 61(3): 763-788.
- Murray, Fiona, Scott Stern, Georgina Campbell, and Alan MacCormack. 2012. "Grand Innovation Prizes: A Theoretical, Normative, and Empirical Evaluation." *Research Policy* 41(10): 1779-1792.
- Kremer, Michael, and Heidi Williams. 2010. "Incentivizing Innovation: Adding to the Toolkit." *Innovation Policy and the Economy* 1: 1-17.
- Williams, Heidi. 2012. "Innovation Inducement Prizes: Connecting Research to Policy." *Journal of Policy Analysis and Management* 31(3): 752-776.
- Kay, Luciano. 2011. "The Effect of Inducement Prizes on Innovation: Evidence from the Ansari XPrize and the Northrop Grumman Lunar Lander Challenge." *R&D Management* 41(4): 360-377.

Economics of the Patent System

- Nordhaus, William D. 1967. "The Optimal Life of a Patent." Cowles Foundation Discussion Paper #241.
- (*) Lemley, Mark A., and Carl Shapiro. 2005. "Probabilistic Patents." *Journal of Economic Perspectives* 19(2): 75-98.
- (*) Scotchmer, Suzanne. 1991. "Standing on the Shoulders of Giants: Cumulative Research and the Patent Law." *Journal of Economic Perspectives* 5(1): 29-41.

- (*) Sampat, Bhaven, and Heidi L. Williams. 2015. "How Do Patents Affect Follow-on Innovation? Evidence from the Human Genome." NBER Working Paper #21666.
- Galasso, Alberto, and Mark Schankerman. 2015. "Patents and Cumulative Innovation: Causal Evidence from the Courts." *Quarterly Journal of Economics* **130**(1): 317-369.
- Hall, Bronwyn H. 2005. "Exploring the Patent Explosion." *Journal of Technology Transfer* **30**(1-2): 35-48.
- Hall, Bronwyn H., and Dietmar Harhoff. 2012. "Recent Research on the Economics of Patents." NBER Working Paper #17773.
- Merges, Robert P., and Richard R. Nelson. 1990. "On the Complex Economics of Patent Scope." *Columbia Law Review* **90**(4): 839-916.
- Moser, Petra, Joerg Ohmstedt, and Paul W. Rhode. 2015. "Patent Citations and the Size of the Inventive Step — Evidence From Hybrid Corn." NBER Working Paper #21443.
- Graham, Stuart, and Saurabh Vishnubhakat. 2013. "Of Smart Phone Wars and Software Patents." *Journal of Economic Perspectives* **27**(1): 67-86.
- Ouellette, Lisa Larrimore. 2012. "Do Patents Disclose Useful Information?" *Harvard Journal of Law & Technology* **25**(2): 532-593.
- Bessen, James. 2002. "Patents and the Diffusion of Technical Information." *Economics Letters* **86**(1): 121-128.
- Graham, Stuart, and Deepak Hegde. 2015. "Disclosing Patents' Secrets." *Science* **347**(6219): 236-237.
- Roin, Benjamin N. 2005. "The Disclosure Function of the Patent System (Or Lack Thereof)." *Harvard Law Review* **118**(6): 2007-2028.
- Jaffe, Adam B., and Josh Lerner. 2006. "Innovation and its Discontents." *Innovation Policy and the Economy* **6**: 27-65.
- Cohen, Lauren, Umit G. Gurun, and Scott Duke Kominers. 2014. "Patent Trolls." NBER Working Paper #20322.
- Tucker, Catherine E. 2016. "The Effect of Patent Litigation and Patent Assertion Entities on Entrepreneurial Activity." *Research Policy*, Forthcoming.
- Graham, Stuart J.H., and Dietmar Harhoff. 2014. "Separating Patent Wheat from Chaff: Would the US Benefit from Adopting Patent Post-Grant Review?" *Research Policy* **43**(9): 1649-1659.

Patenting and Firm Behavior

- (*) Budish, Eric, Benjamin N. Roin, and Heidi Williams. 2015. "Do Firms Underinvest in Long-Term Research? Evidence from Cancer Clinical Trials." *American Economic Review* **105**(7): 2044-2085.
- (*) Hall, Bronwyn H., and Rosemarie H. Ziedonis. 2001. "The Patent Paradox Revisited: An Empirical Study of Patenting in the US Semiconductor Industry, 1979-95." *RAND Journal of Economics* **32**(1): 101-128.
- Kortum, Samuel, and Joshua Lerner. 1998. "Stronger Protection or Technological Revolution: What is Behind the Recent Surge in Patenting?" *Carnegie-Rochester Conference Series on Public Policy* **48**: 247-304.
- Gaulé, Patrick. 2015. "Patents and the Success of Venture-Capital Backed Startups: Using Examiner Assignment to Estimate Causal Effects." Working Paper, CERGE-EI. Available at SSRN: <http://ssrn.com/abstract=2633503>.
- Czarnitzki, Dirk, Bronwyn H. Hall, and Hanna Hottenrott. 2014. "Patents as Quality Signals? The Implications for Financing Constraints on R&D." NBER Working Paper #19947.
- Rivette, Kevin G., and David Kline. 2000. "Discovering New Value in Intellectual Property." *Harvard Business Review* **78**(1): 54-66.
- Shapiro, Carl. 2000. "Navigating the Patent Thicket: Cross Licenses, Patent Pools, and Standard Setting." *Innovation Policy and the Economy* **1**: 119-150.
- Cohen, Wesley M., Richard R. Nelson, and John P. Walsh. 2000. "Protecting their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)." NBER Working Paper #7552.

- Belenzon, Sharon. 2011. "Cumulative Innovation and Market Value: Evidence from Patent Citations." *Economic Journal* **122**(559): 265-285.
- Heller, Michael A., and Rebecca S. Eisenberg. 1998. "Can Patents Deter Innovation? The Anticommons in Biomedical Research." *Science* **280**(5364): 698-701.
- Hegde, Deepak, David C. Mowery, and Stuart J.H. Graham. 2009. "Pioneering Inventors or Thicket Builders: Which U.S. Firms Use Continuations in Patenting?" *Management Science* **55**(7): 1214-1226.

Patenting and Antitrust

- Lerner, Josh, and Jean Tirole. 2004. "Efficient Patent Pools." *American Economic Review* **94**(3): 691-711.
- Lerner, Josh, and Jean Tirole. 2013. "Standard-Essential Patents." NBER Working Paper #19664.
- Lampe, Ryan, and Petra Moser. 2010. "Do Patent Pools Encourage Innovation? Evidence from the Nineteenth-Century Sewing Machine Industry." *Journal of Economic History* **70**(4): 898-920.
- Lampe, Ryan, and Petra Moser. 2013. "Patent Pools and Innovation in Substitute Technologies: Evidence from the 19th-century Sewing Machine Industry." *RAND Journal of Economics* **44**(4): 757-778.

Secrecy

- Anton, James J., and Dennis A. Yao. 2004. "Little Patents and Big Secrets: Managing Intellectual Property." *RAND Journal of Economics* **35**(1): 1-22.
- Kultti, Klaus, Tuomas Takalo, and Juuso Toikka. 2007. "Secrecy versus Patenting." *The RAND Journal of Economics* **38**(1): 22-42.
- Lemley, Mark A. 2008. "The Surprising Virtues of Treating Trade Secrets as IP Rights." *Stanford Law Review* **61**(2): 311-353.
- Friedman, David D., William M. Landes, and Richard A. Posner. 1991. "Some Economics of Trade Secret Law." *Journal of Economic Perspectives* **5**(1): 61-72.
- Hall, Bronwyn H., Christian Helmers, Mark Rogers, and Vania Sena. 2014. "The Choice Between Formal and Informal Intellectual Property: A Review." *Journal of Economic Literature* **52**(2): 375-423.
- Arundel, Anthony. 2001. "The Relative Effectiveness of Patents and Secrecy for Appropriation." *Research Policy* **30**(4): 611-624.
- Marx, Matthew, Debbie Strumsky, and Lee Fleming. 2009. "Mobility, Skills, and the Michigan Non-compete Experiment." *Management Science* **55**(6): 875-889.
- Moser, Petra. 2012. "Innovation without Patents: Evidence from World's Fairs." *Journal of Law and Economics* **55**(1): 43-74.

Class 6 The Life Cycle of Inventors October 20

Class 7 Open Science as an Economic Institution October 27

- (*) Dasgupta, Partha, and David. Paul. 1994. "Towards a New Economics of Science." *Research Policy* **23**(5): 487-521.
- (*) 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.
- (*) 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.

- (*) 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.
- (*) Stern, Scott. 2004. "Do Scientists Pay to Be Scientists?" *Management Science* **50**(6): 835-853.
- Waldinger, Fabian. 2013. "Bombs, Brains, and Science: The Role of Human and Physical Capital for the Creation of Scientific Knowledge." Working Paper, University of Warwick.
- 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.
- Bikard, Michaël. 2014. "Is Knowledge Trapped Inside the Ivory Tower? Scientific and Organizational Hurdles to Invention based on Academic Research." Working Paper, London Business School.
- 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.
- Bramoullé, Yann, and Gilles Saint-Paul. 2010. "Research Cycles." *Journal of Economic Theory* **145**(5): 1890-1920.
- Gluckman, Peter. 2012. "Which Science to Fund: Time to Review Peer Review?" Office of the Prime Minister's Science Advisory Committee. Auckland, New Zealand.
- 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.
- Gans, Joshua S., Fiona E. Murray, and Scott Stern. 2013. "Contracting over the Disclosure of Scientific Knowledge: Intellectual Property and Academic Publication." NBER Working Paper #19560.
- Gans, Joshua S., and Fiona Murray. 2013. "Credit History: The Changing Nature of Scientific Credit." NBER Working Paper #19538.
- Gans, Joshua, and Fiona Murray. 2014. "Markets for Scientific Attribution." NBER Working Paper #20677.
- 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.
- Latour, Bruno, and Steven Woolgar. 1979. *Laboratory Life*. Beverly Hills, CA: Sage Publications.
- Merton, Robert K. 1973. *The Sociology of Science: Theoretical and Empirical Investigation*. Chicago, IL: University of Chicago Press.
- Nelson, Richard R. 1959. "The Simple Economics of Basic Scientific Research." *Journal of Political Economy* **67**(2): 297-306.
- Owen-Smith, Jason. 2001. "Managing Laboratory Work Through Skepticism: Processes of Evaluation and Control." *American Sociological Review* **66**(3): 427-452.
- Rosenberg, Nathan. 1974. "Science, Invention, and Economic Growth." *Economic Journal* **84**(333): 90-108.
- Rosenberg, Nathan. 1982. "How Exogenous is Science?" In, *Inside the Black Box*, pp. 141-158. New York: Cambridge University Press.
- Rosenberg, Nathan. 1990. "Why Do Firms Do Basic Research (with their own money)?" *Research Policy* **19**(2): 165-174.
- Rosenberg, Nathan, and Richard R. Nelson. 1994. "American Universities and Technical Advance in Industry." *Research Policy* **23**(3): 323-348.
- Stephan, Paula. 2013. "The Endless Frontier: Reaping What Bush Sowed?" NBER Working Paper #19687.
- Shi, Feng, Jacob G. Foster, and James A. Evans. 2015. "Weaving the Fabric of Science: Dynamic Network Models of Science's Unfolding Structure." *Social Networks* **43**: 73-85.
- Varmus, Harold. 2009. *The Art and Politics of Science*. New York: W. W. Norton & Company.

- 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.
- Werth, Barry. 1995. *The Billion Dollar Molecule: One Company's Quest for the Perfect Drug*. New York: Simon & Schuster.
- Foster, Jacob G., Andrey Rzhetsky, and James A. Evans. 2015. "Tradition and Innovation in Scientists' Research Strategies." *American Sociological Review* **80**(5): 875-908.
- Jones, Benjamin F., and Bruce A. Weinberg. 2011. "Age Dynamics in Scientific Creativity." *Proceedings of the National Academy of Sciences* **108**(47): 18910-18914.
- Arora, Ashish, Belenzon, Sharon, and Andrea Pataconi. "Killing the Golden Goose? The Decline of Science in Corporate R&D." NBER Working Paper #20902.
- Iaria, Alessandro and Fabian Waldinger. "International Knowledge Flows: Evidence from the Collapse of International Science in the Wake of WWI." Working paper, University of Warwick.

Class 8 Strategic Interaction in Cumulative Innovation Environments

November 2

- (*) Aghion, Philippe, Nick Bloom, Richard Blundell, Rachel Griffith, and Peter Howitt. 2005. "Competition and Innovation: An Inverted U-Relationship." *Quarterly Journal of Economics* **120**(2): 701-728.
- (*) Scotchmer, Suzanne. 1991. "Standing on the Shoulders of Giants: Cumulative Research and the Patent Law." *Journal of Economic Perspectives* **5**(1): 29-41.
- (*) Segal, Ilya, and Michael Whinston. 2007. "Antitrust in Innovative Industries." *American Economic Review* **97**(5): 1703-1730.
- (*) Gans, Joshua S. 2011. "When is Static Analysis a Sufficient Proxy for Dynamic Considerations? Reconsidering Antitrust and Innovation." *Innovation Policy and the Economy* **11**: 55-78
- Evans, David S., and Richard Schmalensee. 2002. "Some Economic Aspects of Antitrust Analysis in Dynamically Competitive Industries." *Innovation Policy and the Economy* **2**: 1-49.
- Aghion, Philippe, Christopher Harris, Peter Howitt, and John Vickers. 2001. "Competition, Imitation and Growth with Step-by-Step Innovation." *Review of Economic Studies* **68**(3): 467-492.
- Hopenhayn, Hugo A., Gerard Llobet, and Matthew Mitchell. 2006. "Rewarding Sequential Innovators: Prizes, Patents and Buyouts." *Journal of Political Economy* **114**(6): 1041-1068.
- O'Donoghue, Ted, Suzanne Scotchmer, and Jacques-François Thisse. 1998. "Patent Breadth, Patent Life and the Pace of Technological Improvement." *Journal of Economics and Management Strategy* **7**(1): 1-32.
- Klepper, Steven. 1996. "Entry, Exit, Growth, and Innovation over the Product Life Cycle." *American Economic Review* **86**(3): 562-583.
- Utterback, James. 1994. *Mastering the Dynamics of Innovation*. Boston, MA: Harvard Business School Press.

Class 9 Entrepreneurial Strategy

November 10

- (*) 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. **READ pp. 618-626.**
- (*) Henderson, Rebecca. 1993. "Underinvestment and Incompetence as Responses to Radical Innovation: Evidence from the Photolithographic Equipment Industry." *RAND Journal of Economics* **24**(2): 248-270.

- (*) Gans, Joshua S., and Scott Stern. 2003. "The Product Market and the Market for Ideas: Commercialization Strategies for Technology Entrepreneurs." *Research Policy* 32: 333-350.
- (*) Gilbert, Richard. 2006. "Looking for Mr. Schumpeter: Where Are We in the Competition-Innovation Debate?" *Innovation Policy and the Economy* 6: 159-215.
- (*) Bresnahan, Timothy F., Shane Greenstein, and Rebecca M. Henderson. 2012. "Schumpeterian Competition and Diseconomies of Scope: Illustration from the Histories of Microsoft and IBM." In Josh Lerner, and Scott Stern (Eds.), *The Rate & Direction of Inventive Activity Revisited*, pp. 203-271. Chicago, IL: University of Chicago Press.
- Marx, Matt, Joshua S. Gans, and David H. Hsu. 2014. "Dynamic Commercialization Strategies for Disruptive Technologies: Evidence from the Speech Recognition Industry." *Management Science* 60(12): 3103-3123.
- Lerner, Joshua. 1997. "An Empirical Exploration of a Technology Race." *RAND Journal of Economics* 28(2): 228-247.
- Schumpeter, Joseph. 1942. "The Process of Creative Destruction." Chapter VII, pp. 81-86 in *Capitalism, Socialism, and Democracy*. New York, NY: Harper & Row.
- Anton, James J., and Dennis A. Yao. 1994. "Expropriation and Inventions: Appropriable Rents in the Absence of Property Rights." *American Economic Review* 84(1): 190-209.
- Kortum, Samuel, and Joshua Lerner. 2000. "Assessing the Contribution of Venture Capital to Innovation." *RAND Journal of Economics* 31(4): 674-692.
- Hellmann, Thomas, and Manju Puri. 2000. "The Interaction between Product Market and Financing Strategy: The Role of Venture Capital." *Review of Financial Studies* 13(4): 959-984.
- Hellmann, Thomas, and Enrico Perotti. 2011. "The Circulation of Ideas in Firms and Markets." *Management Science* 57(10): 1813-1826.
- Hsu, David H. 2006. "Venture Capitalists and Cooperative Start-up Commercialization Strategy." *Management Science* 52(2): 204-219.
- Adner, Ron, and Peter Zemsky. 2005. "Disruptive Technologies and the Emergence of Competition." *RAND Journal of Economics* 36(2): 361-377.
- Baumol, William J. 2002. "Entrepreneurship, Innovation and Growth: The David-Goliath Symbiosis." Working Paper, New York University.
- Cohen, Wesley, and Richard Levin. 1989. "Empirical Studies of Innovation and Market Structure." In Richard Schmalensee, and Robert Willig (Eds.), *Handbook of Industrial Organization*, pp. 1060-1107. Amsterdam: North-Holland.
- Gilbert, Richard, and David Newbery. 1982. "Preemptive Patenting and the Persistence of Monopoly." *American Economic Review* 72(3): 514-526.
- Reinganum, Jennifer. 1983. "Uncertain Innovation and the Persistence of Monopoly." *American Economic Review* 73(4): 741-748.
- Tripsas, Mary. 1997. "Unraveling the Process of Creative Destruction: Complementary Assets and Incumbent Survival in the Typesetter Industry." *Strategic Management Journal* 18: 119-142.

Setting the stage: licensing or integration?

- Teece, David. 1986. "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy." *Research Policy* 15(6): 285-305.
- Teece, David J. 1988. "Technological Change and the Nature of the Firm." In Dosi, G. et al. (eds.) *Technological Change and Economic Theory*, pp. 256-281. London, UK: Pinter.

Arora, Ashish, Fosfuri, Andrea and Alfonso Gambardella. 2001. *Markets for Technology: The Economics of Innovation and Corporate Strategy*. Cambridge MA: The MIT Press.

Arora, Ashish and Alfonso Gambardella. 1994. "The Changing Technology of Technical Change: General and Abstract Knowledge and the Division of Innovative Labour." *Research Policy* 23(5): 523-532.

Transaction costs (patents, uncertainty) and competition

Lamoreaux, Naomi and Kenneth Sokoloff. 2001. "Market Trade in Patents and the Rise of a Class of Specialized Inventors in the 19th Century United States." *American Economic Review* 91(2): 39-44.

(*) Gans, Joshua S., David H. Hsu, and Scott Stern. 2002. "When Does Start-up Innovation Spur the Gale of Creative Destruction?" *RAND Journal of Economics* 33(4): 571-586.

Gans, Joshua S., David H. Hsu, and Scott Stern. 2008. "The Impact of Uncertain Intellectual Property Rights on the Market for Ideas." *Management Science* 54(5): 982-997.

Arora Ashish and Marco Ceccagnoli. 2006. "Patent Protection, Complementary Assets, and Firms: Incentives for Technology Licensing." *Management Science* 52(2): 293-308

Gans, Joshua and Scott Stern. 2010. "Is There a Market for Ideas?" *Industrial and Corporate Change* 19(3): 805-837.

(*) Fosfuri, Andrea. 2007. "The Licensing Dilemma: Understanding the Determinants of the Rate of Technology Licensing." *Strategic Management Journal* 27(12): 1141-1158.

Hellmann, Thomas. 2007. "The Role of Patents for Bridging the Science to Market Gap." *Journal of Economic Behavior and Organization* 63(4): 624-657.

General-Purpose Technologies

Rosenberg, Nathan. 1976. "Technological Change in the Machine Tool Industry," in Rosenberg, N. (ed.) *Perspectives on Technology*, pp. 11-31. Cambridge, MA: Cambridge University Press.

Bresnahan, Timothy and Alfonso Gambardella. 1998. "The Division of Inventive Labor and the Extent of the Market." In Helpman, E. (ed.) *General Purpose Technologies and Economic Growth*, pp. 253-281. Cambridge, MA: The MIT Press.

(*) Gambardella, Alfonso and Marco Giarratana. 2013. "General Technological Capabilities, Product Market Fragmentation, and Markets for Technology: Evidence from the Software Security Industry." *Research Policy* 42(2): 315-325.

The division of innovative labor

(*) Arora, Ashish, Fosfuri, Andrea, and Gambardella, Alfonso. 2001. "Specialized Technology Suppliers, International Spillovers and Investments: Evidence from the Chemical Industry." *Journal of Development Economics* 65(1): 31-54.

Serrano, Carlos. 2015. "Estimating the Gains from Trade in the Market for Patent Rights." Available for download at http://www.econ.upf.edu/~cserrano/papers/gainsfromtrade_paper.pdf

Galasso, Alfonso, Mark Schankerman, and Carlos Serrano. 2013. "Trading and Enforcing Patent Rights." *RAND Journal of Economics* 44(2): 275-312.

Licensing by large and small firms

Gambardella, Alfonso, Paola Giuri, and Alessandra Luzzi. 2007. "The Market for Patents in Europe." *Research Policy* 36(8): 1163-1183.

(*) Arora, Ashish, Andrea Fosfuri, and Thomas Rønde. 2013. "Managing Licensing in a Market for Technology." *Management Science* 59(5): 1092-1106.

Cantoni, Davide, and Noam Yuchtman. 2014. "Medieval Universities, Legal Institutions, and the Commercial Revolution." *Quarterly Journal of Economics* **129**(2): 823-887.

Bikard, Michaël. 2014. "Hurdles to Invention Based on Academic Science: Evidence from 'Knowledge Twins'." Working Paper, Working Paper, London Business School. Available at SSRN: <http://ssrn.com/abstract=2333413>.

Generalities

Griliches, Zvi. 1979. "Issues in Assessing the Contribution of Research and Development to Productivity Growth." *Bell Journal of Economics* **10**(1): 92-116.

Griliches, Zvi. 1990. "Patent Statistics as Economic Indicators: A Survey." *Journal of Economic Literature* **28**(4): 1661-1707.

Griliches, Zvi. 1994. "Productivity, R&D and the Data Constraint." *American Economic Review* **84**(1): 1-23.

Jaffe, Adam. 1998. "Measurement Issues." In Lewis Branscomb, and James Keller (Eds.), *Investing in Innovation: Creating a Research and Innovation Policy That Works*, pp. 64-84. Cambridge, MA: The MIT Press.

Jaffe, Adam B. 2002. "Building Program Evaluation Into the Design of Public Research Support Programs." *Oxford Review of Economic Policy* **18**(1): 22-34.

Azoulay, Pierre. 2012. "Turn the Scientific Method on Ourselves." *Nature*, **484**(7392): 31-32.

Lane, Julia I., Jason Owen-Smith, Rebecca F. Rosen, and Bruce A. Weinberg. 2015. "New Linked Data on Research Investments: Scientific Workforce, Productivity, and Public Value." *Research Policy* **44**(9): 1659-1671.

Connecting Phenomena to Measurement: Innovation Landscapes

Williams, Heidi L. 2013. "Intellectual Property Rights and Innovation: Evidence from the Human Genome." *Journal of Political Economy* **121**(1): 1-27.

Nagaraj, Abhishek. 2015. "The Private Impact of Public Maps: Landsat Satellite Imagery and Gold Exploration." Working Paper, Massachusetts Institute of Technology.

Murray, Fiona, Philippe Aghion, Mathias Dewatripont, Julian Kolev, and Scott Stern. 2009. "Of Mice and Academics: Examining the Effect of Openness on Innovation." NBER Working Paper #14819.

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.

Azoulay, Pierre, Christian Fons-Rosen, and Joshua S. Graff Zivin. 2015. "Does Science Advance One Funeral at a Time?" NBER Working Paper #21XXX.

Boyack, Kevin W., Richard Klavans, and Katy Börner. 2005. "Mapping the Backbone of Science." *Scientometrics* **64**(3): 351-374.

Catalini, Christian. 2015. "Microgeography and the Direction of Inventive Activity." Working Paper, Working Paper, Massachusetts Institute of Technology. Available at SSRN: <http://ssrn.com/abstract=2126890>.

Jensen, Kyle, and Fiona Murray. 2005. "Intellectual Property Landscape of the Human Genome." *Science* **310**(5746): 239-240.

The "Furious Fives": Experiments, Regression/Matching, Diff-inDiff, RDD, IV

Boudreau, Kevin J., Karim R. Lakhani, and Michael Menietti. 2015. "Performance Responses to Competition across Skill-Levels in Rank Order Tournaments: Field Evidence and Implications for Tournament Design." *RAND Journal of Economics*, Forthcoming.

- Boudreau, Kevin J., and Karim R. Lakhani. 2015. "Open Disclosure of Innovations, Incentives and Follow-on Reuse: Theory on Processes of Cumulative Innovation and a Field Experiment in Computational Biology." *Research Policy* **44**(1): 4-19.
- Azoulay, Pierre, Christopher Liu, and Toby Stuart. 2015. "Social Influence Given (Partially) Deliberate Matching: Career Imprints in the Creation of Academic Entrepreneurs." Working Paper, MIT.
- Azoulay, Pierre, Joshua S. Graff Zivin, and Bhaven N. Sampat. 2010. "The Diffusion of Scientific Knowledge Across Time and Space: Evidence from Professional Transitions for the Superstars of Medicine." Chapter 2 in *The Rate & Direction of Inventive Activity Revisited* (edited by Joshua Lerner and Scott Stern), pp. 107-155, 2012.
- Jaravel, Xavier, Neviana Petkova, and Alex Bell. 2015. "Team-Specific Capital and Innovation." Working Paper, Harvard University. Available at SSRN: <http://ssrn.com/abstract=2669060>.
- Teodoridis, Florenta. 2015. "Generalists, Specialists, and the Direction of Inventive Activity." Working Paper, University of Southern California.
- Finkelstein, Amy. 2004. "Static and Dynamic Effects of Health Policy: Evidence from the Vaccine Industry." *Quarterly Journal of Economics* **119**(2): 527-567.
- Li, Danielle. 2015. "Expertise vs. Bias in Evaluation: Evidence from the NIH." Working Paper, Harvard University.
- Tucker, Catherine. 2008. "Identifying Formal and Informal Influence In Technology Adoption with Network Externalities." *Management Science* **54**(12): 2024-2039.
- Jacob, Brian A., and Lars Lefgren. 2011. "The Impact of Research Grant Funding on Research Productivity." *Journal of Public Economics* **95**(9-10): 1168-1177.
- Kerr, William R., Josh Lerner, and Antoinette Schoar. 2014. "The Consequences of Entrepreneurial Finance: Evidence from Angel Financings." *Review of Financial Studies* **27**(1): 20-55.

Novel Uses of Citation Data

- Trajtenberg, Manuel. 1990. "A Penny for Your Quotes: Patent Citations and the Value of Innovations." *RAND Journal of Economics* **21**(1): 172-187.
- Jaffe, Adam B., Manuel Trajtenberg, and Rebecca Henderson. 1993. "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations." *Quarterly Journal of Economics* **108**(3): 577-598.
- Thompson, Peter, and Melanie Fox-Kean. 2005. "Patent Citations and the Geography of Knowledge Spillovers: A Reassessment." *American Economic Review* **95**(1): 450-460.
- Hall, Bronwyn H., Adam Jaffe, and Manuel Trajtenberg. 2005. "Market Value and Patent Citations." *RAND Journal of Economics* **36**(1): 16-38.
- Azoulay, Pierre, Danielle Li, Joshua S. Graff Zivin, and Bhaven N. Sampat. 2015. "Public R&D Investment and Private Sector Patenting: Evidence from NIH Funding Rules." NBER Working Paper #20889.
- Bikard, Michaël. 2012. "Simultaneous Discoveries as a Research Tool: Method and Promise." Working Paper, Working Paper, London Business School. <http://ssrn.com/abstract=2329605>.
- Catalini, Christian, Nicola Lacetera, and Alexander Oettl. 2015. "The Incidence and Role of Negative Citations in Science." *Proceedings of the National Academy of Sciences* **112**(45): 13823-13826.

Networks

- Guimerà, Roger, Brian Uzzi, Jarrett Spiro, and Luís A. Nunes Amaral. 2005. "Team Assembly Mechanisms Determine Collaboration Network Structure and Team Performance." *Science* **308**(5722): 697-702.
- Foster, Jacob G., Andrey Rzhetsky, and James A. Evans. 2015. "Tradition and Innovation in Scientists' Research Strategies." *American Sociological Review* **80**(5): 875-908.
- Shi, Feng, Jacob G. Foster, and James A. Evans. 2015. "Weaving the Fabric of Science: Dynamic Network Models of Science's Unfolding Structure." *Social Networks* **43**: 73-85.

Econometric Minutia

- Santos Silva, J.M.C., and Silvana Tenreyro. 2006. "The Log of Gravity." *Review of Economics and Statistics* **88**(4): 641-658.
- Hausman, Jerry, Bronwyn H. Hall, and Zvi Griliches. 1984. "Econometric Models for Count Data with an Application to the Patents-R&D Relationship." *Econometrica* **52**(4): 909-938.
- Hall, Bronwyn H., Jacques Mairesse, and Laure Turner. 2007. "Identifying Age, Cohort and Period Effects in Scientific Research Productivity: Discussion and Illustration Using Simulated and Actual Data on French Physicists." *Economics of Innovation and New Technology* **16**(2): 159-177.
- Windmeijer, Frank. 2008. "GMM for Panel Data Count Models." In Mátyás László, and Patrick Sevestre (Eds.), *The Econometrics of Panel Data*, pp. 603-624. Berlin Heidelberg: Springer-Verlag.
- Wooldridge, Jeffrey M. 1997. "Quasi-Likelihood Methods for Count Data." In M. Hashem Pesaran, and Peter Schmidt (Eds.), *Handbook of Applied Econometrics*, pp. 352-406. Oxford: Blackwell.
- Bertanha, Marinho, and Petra Moser. 2016. "Spatial Errors in Count Data Regressions." *Journal of Econometric Methods* **5**(1): xxx-xxx. Available at SSRN: <http://ssrn.com/abstract=2406216>.

PROBLEM SET #2 DUE!

Class 12 The Measurement of Entrepreneurial Ecosystems

December 1

- (*) Furman, Jeffrey L., Michael E. Porter, and Scott Stern. 2002. "The Determinants of National Innovative Capacity." *Research Policy* **31**(6): 899-933.
- (*) Nelson, Richard R., and Nathan Rosenberg. 1993. "Technical Innovations and National Systems." In Richard R. Nelson (Ed.), *National Innovation Systems*, pp. 3-21. New York: Oxford University Press.
- Delgado, Mercedes, Michael E. Porter, and Scott Stern. 2009. "Clusters, Convergence, and Economic Performance." Working Paper, MIT.