14.461: Part I: Technology and the Macroeconomy

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Course Logistics

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Lectures:	TuTh	1:00-2:30 pm	E51-361
Recitations:	Fr	2:30-4:00 pm	E51-361
Office hours:	Fr	4:00-5:30 pm	E52-314

Course Overview

This course will cover selected topics in theoretical and empirical analysis of technology and technological change.

There will be three problem sets, which will count towards 30% of your final grade. The remaining 70% will be from a project due in November (exact time to be determined). This project will either be a proposal for a research article, or application of an empirical paper from a prearranged list, or a detailed critique and extension of an existing theoretical article. More details on the available choices for the project will be provided later.

Please note that two of the lectures will be on Friday during the recitation time.

Reading List

Review of Basic Models of Endogenous Technological Progress (one lecture)

Main reading:

- Acemoglu, Daron (2008) *Introduction to Modern Economic Growth*, Chapters 13 and 14, Princeton University Press, Princeton.
- Aghion, Philippe and Peter Howitt (1992) "A Model of Growth Through Creative Destruction." *Econometrica*, 60(2), pp. 323-351.

Other references:

- Aghion, Philippe and Peter Howitt (2008) *The Economics of Growth*, MIT Press, Cambridge (USA).
- Backus, David, Patrick J. Kehoe and Timothy J. Kehoe (1992) "In Search of Scale Effects in Trade and Growth." *Journal of Economic Theory*, 58(2), pp. 377-409.
- Grossman, Gene and Elhanan Helpman (1991) "Quality Ladders in the Theory of Growth." *Review of Economic Studies*, 58(1), pp. 43-61.
- Jones, Charles I (1995) "Time Series Tests of Endogenous Growth Models." *Quarterly Journal of Economics*, 110(2), pp. 495-525.
- Romer, Paul (1987) "Growth Based on Increasing Returns Due to Specialization." *American Economic Review Papers and Proceedings*, pp. 77(2), 56-62
- Romer, Paul M. (1990) "Endogenous Technological Change." *Journal of Political Economy* 98(5), pp. S71-S102.
- Williams, Heidi (2010) "Intellectual Property Rights and Innovation: Evidence from the Human Genome." *Journal of Political Economy*, 121(1), pp. 1-27.

Knowledge Spillovers and Diffusion (one lecture)

Main reading:

- Bloom, Nicholas, Mark Schankerman and John Van Reeenen, J. (2013) "Identifying Technology Spillovers and Product Market Rivalry." *Econometrica*, 81(4), pp. 1347-1393.

- Jaffe, Adam, Manuel Trajtenberg and Rebecca Henderson (1993) "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations." *Quarterly Journal of Economics*, 108(3), pp. 577-598.
- Kerr, William (2008) "Ethnic Scientific Communities and International Technology Diffusion." *The Review of Economics and Statistics*, 90(3), pp. 518-537

Other references:

- Adams, James D., and Adam Jaffe (1996) "Bounding the Effects of R&D: An Investigation Using Matched Establishment-Firm Data." *RAND Journal of Economics*, 27(4), pp. 700-721.
- Boldrin, Michele and David K. Levine (2010) *Against Intellectual Monopoly*, Cambridge University Press, Cambridge (UK).
- Griliches, Zvi (1957) "Hybrid Corn: An Exploration in the Economics of Technological Change." *Econometrica*, 25(4), pp. 501-522.
- Griliches, Zvi (1992) "The Search for R&D Spillovers." *Scandinavian Journal of Economics*, 94, S29-47.
- Irwin, Douglas and Peter Klenow (1994) "Learning by Doing Spillovers in the Semiconductor Industry." *Journal of Political Economy*, 102(6), pp. 1200-1227.
- Jaffe, Adam (1986) "Technological Opportunity and Spillovers of R&D: Evidence from Firms' Patents, Profits and Market Value." *American Economic Review*, 76(5), pp. 984-1001.
- Moser, Petra (2005) "How Do Patent Laws Influence Innovation? Evidence from Nineteenth-Century World Fairs." *American Economic Review*, 95(4), pp. 1214-1236.
- Pakes, Ariel (1987) "Patents as Options: Some Estimates of the Value of Holding European Patent Stocks." *Econometrica*, 54(4), pp. 755-784.

Competition, Policy and Technological Change (one lecture)

Main reading:

- Acemoglu, Daron and Ufuk Akcigit (2012) "Intellectual Property Rights Policy, Competition and Innovation." *Journal of the European Economic Association*, 10(1), pp. 1-42.

- Aghion, Philippe, Nicholas Bloom, Richard Blundell, Rachel Griffith and Peter Howitt (2005) "Competition and Innovation: An Inverted-U Relationship." *Quarterly Journal of Economics*, 120(2), pp. 701-728.
- Segal, Ilya, and Michael Whinston (2007) "Antitrust in Innovative Industries." *American Economic Review*, 97(5), pp. 1703-1730.

Other references:

- 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), pp. 467-492.
- Aghion, Philippe and Rachel Griffith (2007) *Competition and Growth: Reconciling Theory and Evidence*, MIT Press, Cambridge (USA).
- Boldrin, Michele and David K. Levine (2010) *Against Intellectual Monopoly*, Cambridge University Press, Cambridge (UK).
- Boldrin, Michele and David K. Levine (2008) "Perfectly Competitive Innovation. "*Journal of Monetary Economics*, 55(3), pp. 435-453.

Technology, Tasks and the Labor Market (one lecture)

Main reading:

- Acemoglu, Daron and David Autor (2010) "Skills, Tasks and Technologies: Implications for Employment and Earnings" in O. Ashenfelter and D. Card *Handbook of Labor Economics*, volume 4, North Holland.
- Foote, Christopher L. and Richard W. Ryan (2014) "Labor Market Polarization over the Business Cycle."*NBER Macroeconomics Annual 2014*, 29(1), pp. 371-413.
- Jaimovich, Nir and Henry Siu (2014) "The Trend Is the Cycle: Job Polarization and Jobless Recoveries." Duke University mimeo.

Other references:

- Acemoglu, Daron (2002) "Technical Change, Inequality and the Labor Market." *Journal of Economic Literature*, 40(1), pp. 7-72.
- Autor, David H. and David Dorn (2013) "The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market." *American Economic Review*, 103(5), pp. 1553-1597.

- Autor, David H., Lawrence Katz and Alan Krueger (1998) "Computing Inequality: Have Computers Changed the Labor Market?" *Quarterly Journal of Economics*, 113(4), pp. 1169-1214.
- Autor, David H., Frank Levy and Richard J. Murnane (2003) "The Skill Content of Recent Technological Change: An Empirical Exploration." *Quarterly Journal of Economics*, 118(4), pp. 1279-1333.
- Costinot, Arnaud and Jonathan Vogel (2015) "Matching and Inequality in the World Economy." *Journal of Political Economy*, 118(4), pp. 747-786.
- Feenstra, Robert and Gordon Hanson (1999) "The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979-1990." *Quarterly Journal of Economics* , 114(3), pp. 907-940.
- Grossman, Gene and Ross-Hansberg Esteban (2010) "Trading Tasks: A Simple Theory of Offshoring." *American Economic Review*, 98(5), pp. 1978-1997.
- Rodriguez-Clare, Andres (2010) "Offshoring in a Ricardian World." *American Economic Journal: Macroeconomics*, 2(10), pp. 227-258.
- Teulings, Coen N. (1995) "The Wage Distribution in a Model of Assignment of Skills to Jobs." *Journal of Political Economy*, 103(1), pp. 280-315.
- Tinbergen, Jan (1975) *Income Difference: Recent Research*, Amsterdam: North-Holland Publishing Company, 1975.

Directed Technological Change and Implications (three lectures)

Main reading:

- Acemoglu, Daron (2008) *Introduction to Modern Economic Growth*, Chapter 15.
- Acemoglu, Daron (2002) "Directed Technical Change." *Review of Economic Studies*, 69(4), pp. 781-809.
- Acemoglu, Daron (2007) "Equilibrium Bias of Technology." *Econometrica*, 75(5), pp. 1371-1409.
- Acemoglu, Daron (2010) "When Does Labor Scarcity Encourage Innovation." *Journal of Political Economy*, 118(6), pp. 1037-1078.
- Acemoglu, Daron and Joshua Linn (2004) "Market Size in Innovation: Theory and Evidence from the Pharmaceutical Industry." *Quarterly Journal of Economics*, 119(3), pp. 1049-1090.

- Acemoglu, Daron and Pascual Restrepo (2016) "The Race between Men and Machine: Implications for Economic Growth, Factor Shares and Employment." NBER Working Paper.
- Bloom, Nicholas, Mirko Draca and John Van Reenen (2016) "Trade Induced Technical Change: The Impact of Chinese Imports on Innovation, Diffusion and Productivity." *Review of Economic Studies*, 83(1), pp. 87-117.
- Finkelstein, Amy (2004) "Static and Dynamic Effects of Health Policy: Evidence from the Vaccine Industry." *Quarterly Journal of Economics*, 119(2), pp. 527-564.
- Hanlon, Walker (2015) "Necessity Is the Mother of Invention: Input Supplies and Directed Technical Change." *Econometrica*, 83(1), pp. 67-100.

Other references:

- Acemoglu, Daron (1998) "Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality." *Quarterly Journal of Economics*, 113(4), pp. 1055-1089.
- Acemoglu, Daron (2003) "Patterns of Skill Premia." *Review of Economic Studies*, 70(2), pp. 199-230.
- Acemoglu, Daron (2003) "Labor- and Capital-Augmenting Technical Change." *Journal of European Economic Association,* 1(1), pp. 1-37.
- Acemoglu, Daron, Gino Gancia, and Fabrizio Zilibotti (2012) "Offshoring and Directed Technical Change." *American Economic Journal: Macroeconomics,* 7(3), pp. 84-122.
- Epifani, Paolo and Gino Gancia (2006) "The Skill Bias of World Trade." *The Economic Journal,* 118(530), pp. 927-960.
- Jones, Charles I. (2005) "The Shape of Production Functions and the Direction of Technical Change." *Quarterly Journal of Economics*, 120(2), pp. 517-549.
- Thoenig, Matthias and Thierry Verdier (2003) "A Theory of Defensive Innovations and Globalization." *American Economic Review*, 93(3), pp. 709-728.

Innovation and Reallocation (one lecture, DA)

Main reading:

- Acemoglu, Daron, Ufuk Akcigit, Nicholas Bloom and William Kerr (2013) "Innovation, Reallocation and Growth." NBER Working Paper.

- Klette, Tor Jacob and Samuel Kortum (2004) "Innovating Firms and Aggregate Innovation." *Journal of Political Economy*, 112(5), pp. 986-1018.
- Lentz, Rasmus and Dale Mortensen (2008) "An Empirical Model of Growth through Product Innovation." *Econometrica*, 76(6), pp. 1313-1373.

Other references:

- Acemoglu, Daron and Dan Cao (2010) "Innovation by Entrants and Incumbents." *Journal of Economic Theory*, 157, pp. 255-294.
- Akicigit, Ufuk and William Kerr (2010) "Growth through Heterogeneous Innovation." NBER Working Paper.
- Axtell, R.L. (2001) "Zipf Distribution of US Firm Sizes." *Science*, 293(5536), pp. 1818-1820.
- Foster, Lucia, John Haltiwanger and Chad Syverson (2008) "Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?" *American Economic Review*, 98(1), pp. 394-425.
- Gabaix, Xavier (1999) "Zipf's Law for Cities: An Explanation." *Quarterly Journal of Economics*, 114(3), pp. 739-767.
- Guner, Nezih, Gustavo Ventura and Xu Yi (2008) "Macroeconomic Implications of Size-Dependent Policies." *Review of Economic Dynamics*, 11(4), pp. 721-744.
- Hopenhayn, Hugo A. (1992) "Entry, Exit, and firm Dynamics in Long Run Equilibrium." *Econometrica*, 60(5), pp. 1127-1150.
- Lucas, Robert. E. Jr. (1978) "On the Size Distribution of Business Firms." *Bell Journal of Economics*, 9(2), pp. 508-523.
- Luttmer, G.J. Erzo (2007) "Technology, Diffusion and Growth." *Journal of Economic Theory*, 147(2), pp. 602-622.
- Luttmer, G.J. Erzo (2010) "Models of Growth and Firm Heterogeneity." *Annual Review of Economics*, 2, 547-576.
- Restuccia, Diego and Richard Rogerson (2008) "Policy Distortions of Aggregate Productivity with Heterogeneous Plants." *Review of Economic Dynamics*, 11(4), pp. 707-720.
- Rossi-Hansberg, Esteban and Mark L.J. Wright (2015) "Establishment Size Dynamics in the Aggregate Economy." *American Economic Review*, 97(5), pp. 1639-1666.

Climate Change and Technology (one lecture)

Main reading:

- Acemoglu, Daron, Philippe Aghion, Leonardo Bursztyn and David Hemous (2012) "The Environment and Directed Technical Change." *American Economic Review*, 102(1), pp. 131-166.
- Acemoglu, Daron, Ufuk Akcigit, William Kerr and Douglas Hanley (2016) "Transition to Clean Technology." *Journal of Political Economy*, 124(1), pp. 52-104.
- Golosov, Mikhail, John Hassler, Per Krusell, and Aleh Tsyvinski (2014) "Optimal Taxes on Fossil Fuel in General Equilibrium." *Econometrica*, 82(1), pp. 41-88.

Other references:

- Aghion, Philippe, Antoin Dechezlepretre, David Hemous, Ralf Martin, and John Van Reenen (2003) "Carbon Taxes, Path Dependency and Directed Technical Change: Evidence from the Auto Industry." *Journal of Political Economy*, 124(1), pp. 1-51.
- Newell, Richard, Adam Jaffee and Robert Stavins (1999) "The Induced Innovation Hypothesis and Energy-Saving Technological Change." *Quarterly Journal of Economics*, 114(3), pp. 941-975.
- Nordhaus, William (2008) *A Question of Balance: Weighing the Options on Global Warming Policies*, Yale University Press, New Haven.
- Popp, David (2002) "Induced Innovation and Energy Prices." *American Economic Review*, 92(1), pp. 160-180.

Innovation, Creativity and Technological Progress (one lecture)

Main reading:

- Acemoglu, Daron, Ufuk Akcigit and Murat Alp Celik (2015) "Young, Restless and Creative: Openness to Disruption and Creative Innovations." NBER Working Paper.
- Acemoglu, Daron, James Robinson and Thierry Verdier (2016) "Asymmetric Growth and Institutions in an Interdependent World." *Journal of Political Economy* (forthcoming).
- Akcigit, Ufuk, Murat Alp Celik and Jeremy Greenwood (2016) "Buy, Keep or Sell: Theory and Evidence from Patent Resales." *Econometrica* (forthcoming).

- Jones, Benjamin (2009) "The Burden of Knowledge and the Death of the Renaissance Man: Is Innovation Getting Harder." *Review of Economic Studies*, 76(1), pp. 283-317.

Other references:

- Acemoglu, Daron, Philippe Aghion, Claire Lelarge, John Van Reenen and Fabrizio Zilibotti (2007) "Technology, Information and the Decentralization of the Firm." *Quarterly Journal of Economics*, 122(4), pp. 1759-1799.
- Acemoglu, Daron, Philippe Aghion and Fabrizio Zilibotti (2006) "Distance to Frontier, Selection, and Economic Growth." *Journal of the European Economic Association*, 4(1), pp. 37-74.
- Akicigit, Ufuk (2010) "Firm Size Innovation Dynamics and Growth." Mimeo.
- Atkeson, Andrew and Ariel Burstein (2009) "Innovation, Firm Dynamics and International Trade." *Journal of Political Economy*, 118(3), pp. 433-484.
- Brezis, Elise, Paul R. Krugman and Daniel Tsiddo (1993) "Leapfrogging in International Competition: A Theory of Cycles in National Leadership." *American Economic Review*, 83(5), pp. 1211-1219.
- Christensen, Clayton M. (1997) *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business Press, Boston (USA).
- Galenson, David W. and Bruce Weinberg (2001) "Creating Modern Art: The Careers of Painters in France from Impressionism to Cubism." *American Economic Review*, 91(4), pp. 1063-1071.
- Gorodnichenko, Yuriy and Gerard Roland (2016) "Culture, Institutions and the Wealth of Nations." *Review of Economics and Statistics* (forthcoming).
- Jones, Benjamin (2010) "Age and Great Invention." *Review of Economics and Statistics*, 92(1), pp. 1-14.
- König, Michael, Jan Lorenz and Fabrizio Zilibotti (2016) "Innovation vs. Imitation and the Evolution of Productivity Distributions." *Theoretical Economics* (forthcoming).
- Kortum, Samuel (1997) "Research, Patenting and Technological Change." *Econometrica*, 65(6), pp. 1389-1419.
- Lucas, Robert E. and Benjamin Moll (2014) "Knowledge Growth and the Allocation of Time." *Journal of Political Economy*, 122(1), pp. 1-52.
- Schumpeter, J. A. (1934) *The Theory of Economic Development*, Harvard University Press, Cambridge (USA).

Misallocation and Productivity Differences Across Countries (one lecture)

Main reading:

- Acemoglu, Daron and Fabrizio Zilibotti (2001) "Productivity Differences." *Quarterly Journal of Economics*, 116(2), pp. 563-606.
- Hsieh, Chang-Tai and Peter Klenow (2009) "Misallocation and Manufacturing TFP in China and India." *Quarterly Journal of Economics*, 124(4), pp. 1403-1448.
- Song, Michael, Storlesseten, Kjetil and Zilibotti, Fabrizio (2011) "Growing Like China." *American Economic Review*, 101(1), pp. 196-233.

Other references:

- Atkinson, Anthony B. and Joseph E. Stiglitz (1969) "A New View of Technological Change." *Economic Journal*, 79(315), pp. 573-578.
- Basu, Susanto and David N. Weil (1998) "Appropriate Technology and Growth." *Quarterly Journal of Economics*, 113(4), pp. 1025-1054.
- Lewis, William (2004) *The Power of Productivity: Wealth, Poverty and the Threat to Global Stability*, University of Chicago Press, Chicago (USA).
- Parente, Stephen L. and Edward C. Prescott (1994) "Barriers to Technology Adoption and Development." *Journal of Political Economy*, 102(2), pp. 298-321.

Network Linkages: Technology, Productivity and Volatility (two lectures)

Main reading:

- Acemoglu, Daron, Ufuk Akcigit, and William Kerr (2015) "Networks and the Macroeconomy: An Empirical Exploration." *NBER Macroeconomics Annual 2015*, 30(1), pp. 276-335.
- Acemoglu, Daron, Ufuk Akcigit, and William Kerr (2016) "The Innovation Network." *Proceedings of the National Academy Of Sciences* (forthcoming).
- Acemoglu, Daron and Pablo Azar (2016) "Endogenous Production Networks" (in progress).
- Acemoglu, Daron, Vasco Carvalho, Asuman Ozdaglar and Alireza Tahbaz-Salehi (2012) "Network Origins of Aggregate Fluctuations." *Econometrica*, 80(5), pp. 1977-2016.

- Acemoglu, Daron, Asuman Ozdaglar and Alireza Tahbaz-Salehi (2015) "Systemic Risk and Stability in Financial Networks." *American Economic Review*, 105(2), pp. 564-608.
- Acemoglu, Daron, Asuman Ozdaglar and Alireza Tahbaz-Salehi (2016) "Microeconomic Shocks and Macroeconomic Tail Risks." *American Economic Review* (forthcoming).
- Carvalho, Vasco and Xavier Gabaix (2013) "The Great Diversification and Its Undoing." *American Economic Review*, 103(5), pp. 1697-1727.
- Elliott, Matthew, Benjamin Golub, and Matthew Jackson (2014) "Financial Networks and Contagion." *American Economic Review*, 104(10), pp. 3115-3153.
- Forrester, Andrew, Pierre-Daniel Sarte and Mark Watson (2011) "Sectoral Vs. Aggregate Shocks: A Structural Factor Analysis of Industrial Production." *Journal of Political Economy*, 119(1), pp. 1-38.
- Jones, Charles I. (2013) "Misallocation, Economic Growth and Input-Output Economics." *Advances in Economic and Econometric Theory: Proceedings of the Tenth World Congress of the Econometric Society*, Daron Acemoglu, Manuel Arellano and Eddie Dekel (editors).

Other references:

- Acemoglu, Daron, David Autor, David Dorn, Gordon Hanson and Brendan Price (2014) "Import Competition and the Great Employment Side of the 2000s." *Journal of Labor Economics*, 34(S1), S141-198.
- Bartelme, Dominick and Yuriy Gorodnichenko (2015) "Linkages and Economic Development." NBER Working Paper.
- Ciccone, Antonio (2002) "Input Chains and Industrialization." *Review of Economic Studies*, 69(3), pp. 565-587.
- Dupor, Bill (1999) "Aggregation and Irrelevancein in Multi-Sector Models." *Journal of Monetary Economics*, 43(2), pp. 391-409.
- Gabaix, Xavier (2011) "The Granular Origins of Aggregate Fluctuations." *Econometrica*, 79(3), pp. 733-772.
- Horvath, Michael (1998) "Cyclicality and Sectoral Linkages: Aggregate Fluctuations from Interdependent Sectoral Shocks." *Review of Economic Dynamics*, 1(4), pp. 781-808.
- Horvath, Michael (2000) "Sectoral Shocks and Aggregate Fluctuations." *Journal of Monetary Economics*, 45(1), pp. 69-106.