

Princeton University
Woodrow Wilson School
Graduate Program

Fall Term - 2004

WWS 581a
Technological Innovation
and Economic Growth

Lecturer F. M. Scherer
fmscherer@comcast.net

The principal objective of this seminar is to provide a solid conceptual foundation for understanding how new technology affects the economy, how economic forces reciprocally affect the emergence of technological changes, and the decision-making processes through which technological innovation occurs. We examine in turn the links between innovation and productivity growth, the role of market forces in motivating and guiding technological changes, the economics of basic science, the management and financing of R&D, the patent system, the links between market structure and innovation, government science and technology policy, and the impact of innovation on international trade and competitiveness.

There is no textbook as such. Purchase of one inexpensive paperback, Scherer, New Perspectives on Economic Growth and Technological Innovation (Brookings: 1999), is recommended. A packet of core materials (marked P) can be obtained from a local copy center, to be designated later. The first two weeks (P) readings will be provided directly. These will complement core readings in books (marked R) and folders (RF) on reserve in the Woodrow Wilson Library. Many journal articles are also available through JSTOR.

Each participant is expected to choose from the menu summarized at the end of this syllabus and write two 800-word issues papers (to be discussed in class), together weighted one-third in the final grade; and to write a term paper, weighted two-thirds, which will be due January 12. Although other topics are possible following consultation, it is suggested that the term paper be a case study of how some scientific or technological innovation came to be.

Reading Assignments

Sept. 9 **Technological Change, Productivity Growth, and**

Economic Welfare.

F. M. Scherer, New Perspectives on Economic Growth and Technological Innovation, chapters 1-3 (pp. 1-51) (R).

Peter Williamson, "Productivity and American Leadership: A Review Article," Journal of Economic Literature, March 1991, pp. 51-68 (P).

Angus Maddison, The World Economy: A Millennial Perspective, 2001, pp. 17-25 and 44-48 (P).

"Modern Wonders," The Economist, Dec. 25, 1993, pp. 47-51 (to be distributed in class).

"Notes on Measuring Productivity Growth," class handout.

"The (Julia?) Child's Guide to e ," class handout.

Sept. 16 **Research, Innovation, and Productivity Growth.**

Zvi Griliches, "R&D and Productivity," in Paul Stoneman, ed., Handbook of the Economics of Innovation and Technological Change pp. 52-89 (R). Stokes HC79.T4 H3534 1995

Scherer, Innovation and Growth, Chapter 3 (R).

Robert McGuckin and Kevin Stiroh, "Computers Can Accelerate Productivity Growth," Issues in Science & Technology, Summer 1998, pp. 41-48; plus the comments by William J. Baumol and Robert Solow in Issues in Science & Technology, Fall 1998, pp. 8-10 (available at www.nap.edu/issues) (P).

Robert Gordon, "Does the 'New Economy' Measure Up to the Great Inventions of the Past?" Journal of Economic Perspectives, Fall 2000, pp. 49-74 (P).

Martin Baily, "The New Economy: Post Mortem or Second Wind?" Journal of Economic Perspectives, Spring 2002, pp. 3-22 (P).

Sept. 23 **Market Forces, Economic Stimuli, and the Innovative Response.**

F. M. Scherer, "The Economics of Innovation and Technological Change," International Encyclopedia of the Social & Behavioral Sciences, vol. 11, pp. 7530-6 (www.sciencedirect.com/science/referenceworks/0080430767).

Jacob Schmookler, "Economic Sources of Inventive Activity," Journal of Economic History, March 1962, pp. 1-20 (RF).

Vernon Ruttan, Binswanger, and Hayami, "Induced Innovation in Agriculture," in C. Bliss and Boserup, Economic Growth and Resources, vol. 3, Natural Resources, pp. 162-189 (RF).

David Popp, "Induced Innovation and Energy Prices," American Economic Review, March 2002, pp. 160-180 (P).

Scherer, New Perspectives on Economic Growth and Technological Innovation, Chapter 6 (R).

National Science Board, Science and Engineering Indicators: 2004, vol. I, Chapter 0, pp. 8-15 (R).

Zumeta and Raveling, "Attracting the Best and Brightest," Issues in Science & Technology, Winter 2002-03, pp. 36-40 (RF).

Sept. 30 **The Economics of Basic Science** (date change probable)

National Science Board, Science and Engineering Indicators: 2004, Chapter 5, pp. 5-7 (R).

Paula Stephan, "An Essay on the Economics of Science," Journal of Economic Literature, September 1996, pp. 1199-1235, in Stephan and Audretsch, The Economics of Science and Innovation, vol. I, pp. 3-39 (Stokes C79.T4 E267 2000).

Donald Stokes, Pasteur's Quadrant: Basic Science and Technological Innovation, Chapter 1 plus pp. 84-89 (R).

National Science Foundation, Technology in Retrospect and Critical Events in Science, Introduction and Parts I and II (R).

Edwin Mansfield, "Academic Research Underlying Industrial Innovations," Review of Economics and Statistics, February 1995, pp. 55-65, in Stephan and Audretsch, The Economics of Science and Innovation, vol. II, pp. 151-161 (R).

Thomas Kuhn, The Structure of Scientific Revolutions (first (1962) edition), Chapter VI (R).

Oct. 7 **Managing and Financing Industrial R&D.**

National Science Board, Science and Engineering Indicators: 2004, Chapter 0, pp. 5-6; Chapter

6, pp. 4-5 and 27-36 (R).

Edwin Mansfield, Industrial Research and Technological Innovation, Chapter 3 (R).

Scherer, New Perspectives on Economic Growth and Technological Innovation, Chapter 5 (R).

Christopher Freeman, The Economics of Industrial Innovation, 2nd edition (1982), Chapter 7 (R).

Oct. 14 The Patent System, Domestic and International.

National Science Board, Science and Engineering Indicators: 2004, Chapter 6, pp. 20-27; Chapter 5, pp. 53-59 (R).

Scherer and Ross, Industrial Market Structure and Economic Performance, pp. 621-630 (R).

Josh Lerner, "150 Years of Patent Protection," American Economic Review, May 2002, pp. 221-225 (P).

Edwin Mansfield et al., "Imitation Costs and Patents," Economic Journal, December 1981, pp. 907-918 (RF).

Adam Jaffe, "The U.S. Patent System in Transition: Policy Innovation and the Innovation Process," Research Policy, April 2000 (RF) (available at <http://www.elsevier.nl/locate/econbase>; click on "Research Policy," vol. 29, issue 4-5).

F. M. Scherer, "A Note on Global Welfare in Pharmaceutical Patenting," The World Economy, July 2004, pp. 1127-1142 (reprints to be distributed in class).

Oct. 21 Technology Diffusion, National and International.

Bronwyn Hall, "Innovation and Diffusion," National Bureau of Economic Research Working Paper 10212, January 2004 (RF).

Vernon Ruttan, Technology, Growth, and Development, Chapter 5 (R) (this is an excellent text covering some of the other seminar material and several industry case studies).

Brian Aitken and Anne Harrison, "Do Domestic Firms Benefit from Direct Foreign Investment? Evidence from Venezuela," American Economic Review, June 1999, pp. 605-618 (P).

Westphal, Kim, and Dahlman, "Reflections on the Republic of Korea's Acquisition of

Technological Capability," in Nathan Rosenberg and Claudio Frischtak, ed., International Technology Transfer: Concepts, Measures, and Comparisons, pp. 167-221 (RF).

Oct 22- Nov. 1 **Fall Recess Week.**

Nov. 4 **Firm Size, Market Structure, and Innovation.**

William J. Baumol, The Free-Market Innovation Machine, Chapters 1, 4, and 5 (R).

James Utterback, Mastering the Dynamics of Innovation, Chapter 2 (R).

Clayton Christensen, The Innovator's Dilemma, pp. ix-xxiv (R).

Jan Hagedoorn, Alfred Link, and Nicholas Vonortas, "Research Partnerships," Research Policy, April 2000, pp. 567-586 (RF). See Oct. 14, Jaffe, for web location.

Gerald Hane, "The Real Lessons of Japanese Research Consortia," and "Interview: Sematech's William J. Spencer," Issues in Science and Technology, Winter 1993-94, pp. 56-68 (www.nap.edu/issues) (RF).

Nov. 11 **Government Science and Technology Policy: The Civilian Sector.**

Lewis Branscomb, "Toward a U.S. Technology Policy," Issues in Science and Technology, Summer 1991, pp. 50-55 (RF).

Christopher Freeman, Technology Policy and Economic Performance, Chapters 1, 2, pp. 55-64, pp. 79-90, and Chapter 5 (R).

Richard R. Nelson, National Innovation Systems, Chapters 1, 2 (R).

Bronwyn Hall and John van Reenen, "How Effective Are Fiscal Incentives for R&D? A Review of the Evidence," Research Policy, April 2000, pp. 449-470 (R). See Oct. 19, Jaffe, for web location.

Nov. 18 **Military and Space Research, Development, and Procurement.**

William Burnett and F. M. Scherer, "The Weapons Industry," in Walter Adams, ed., The Structure of American Industry, eighth ed., Chapter 11 (RF).

C. P. Snow, Science and Government (the whole book; it's a great leisure-time read) (R).

Thomas Hughes, "The Secret Triumph of American Engineering," Invention & Technology, Winter 1999, pp. 56-63 (RF).

Harvey Sapolsky, The Polaris System Development, Chapter 1 (R).

Nov. 23 **Thanksgiving Holiday.**

Dec. 2 **Technology and the International Economy.**

National Science Board, Science and Technology Indicators: 2004, Chapter 6, pp. 4-5 and 10-18 (R).

F. M. Scherer, International High-Technology Competition, pp. 9-23 and 173-181 (R).

Daniel Archibugi and Mario Pianta, "Specialization and Size of Technological Activities in Industrial Countries," in Scherer and Perlman, eds., Entrepreneurship, Technological Innovation, and Economic Growth, pp. 65-85 (RF).

Dec. 19 **Technology and the Work Force. The Long View.**

Jeremy Greenwood, The Third Industrial Revolution: Technology, Productivity, and Income Inequality, pp. 1-25 (RF).

Gary Burtless, "Technological Change and International Trade: How Well Do They Explain the Rise in U.S. Income Inequality?" in Auerbach and Belous, eds., The Inequality Paradox: Growth of Income Disparity, pp. 60-91 (RF).

David Mowery, "Helping Workers Adjust," Issues in Science and Technology, Fall 1987, pp. 22-27 (RF).

F. M. Scherer, New Perspectives on Economic Growth and Technological Innovation, Chapter 7 (R).

Vernon Ruttan, Technology, Growth, and Development, Chapter 14 (R).

Jan. 12 **Term papers due.**

Issues Papers

1. (Sept. 16) What has happened to the New Economy? Has the spurt of productivity growth during the 1990s been only ephemeral, or is it likely to persist after the economy is back

on a long-term growth path?

2. (Sept. 23) Since September 11, 2001, the immigration of S&E students into the United States had declined sharply. Should more be done to encourage the immigration of talented individuals for schooling and work? Does the resulting "brain drain" impair the economic growth of the nations from which they emigrate?

3. (Oct. 7) Is the Silicon Valley venture capital paradigm unique, or can it be exported to other parts of the United States and to other nations?

4. (Oct. 14) Many observers have concluded that the U.S. patent system is seriously in need of reform. See e.g. National Research Council, [A Patent System for the 21st Century](#) (2004). What are the problems? What should be done?

5. (Oct. 14) What measures should be taken to ensure that new pharmaceuticals are developed to deal with the special health problems of less-developed nations? Can the patent system as modified under the Uruguay Round treaty do the job?

6. (Nov. 18) President Bush has proposed that NASA gear up to send human beings to Mars. Can we do it? Should we do it? What are the costs, the benefits?

7. (Dec. 9) Is technological change impoverishing unskilled workers in the leading industrial nations? Is there a new threat even to technically skilled jobs as a result of off-shore sourcing? What should be done about these problems?