Economics of Technological Change

Introduction

This course provides an overview of important issues related to technological change that have attracted the attention of economists up to the present time. Among all social sciences, economics may be argued to have taken the longest and broadest interest in the subject. The specific assumptions and methodologies of mainstream economic analysis have, however, been vigorously criticized more recently for failing to deal with the sources of technological advance. Criticism has basically coalesced on two fronts. First, it is argued that mainstream economics has not paid adequate attention to the institutional setup supporting innovation and economic growth. Second, it is argued that an overly mechanistic approach has failed to take into account the rather evolutionary processes involved in scientific and technological advance. This course attempts to provide a balanced view, taking into account both mainstream and neo-institutional/evolutionary approaches as well as expanding to the appraisal of the sources of new technology.

The overall objective of the course is to assess the economic concepts regarding:
(a) the origins of new technology and its market introduction (innovation);
(b) the process of technological advance and differences between sectors;
(c) the dissemination of innovations within and across firms, industries, and countries;
(d) the impacts—economic benefits and costs—of innovation on individual organizations and on society at large;
(e) policy concerns.

The course makes extensive use of case study material to underline the differences between technologies, industries, and organizations involved in scientific and technological advance, including companies, universities, and government agencies. The discussion flags the currently “hot” topics of research internationally and assists in the delineation of topics for further in-depth research by the students.
Course Requirements

The final grade for the course will be a weighed average of your grades on a term paper, a group presentation and in-class participation, and a take-home final examination. The term paper will account for 50%, in-class participation for 20%, and the final examination for the remaining 30% of the grade.

i. **Term paper.** Work individually. Within certain parameters, you will choose a topic that best suits your research interests. You can take a theoretical approach, an empirical approach, a policy approach, or any combination of these. In case that you choose to create a case study of technological development (products or processes), you must try to apply some of the concepts discussed in class. It is advisable that you choose your topic as soon as possible and communicate with me before you start.

An approach that has worked well in the past for several course participants has been to select a term paper that surveys a particular subject. Such surveys are supposed to consult much broader literature than our syllabus and synthesize it in a creative way. Possible area topics are listed at the end of this syllabus. You are, however, free to venture outside this list.

Papers are due December 5.

ii. **In-class participation.** This refers to:

(a) A student’s general standing in class. You are expected to read regularly the assigned material before a lecture and participate in the general discussion during the lecture.

(b) The class meetings of November 21 and November 28 will be devoted to short presentations and discussion. Class participants will be divided into two large teams, each responsible for a short presentation (30’) on a pre-assigned set of industrial sectors. The purpose of the presentation will be to summarize the evolution of technological advance in the respective sectors and the identification of important issues that would be of interest to economists dealing with systems of sectoral innovation. The rest 90’ of the class meeting will be devoted to debate among all members of the class on the topics proposed for discussion by the presenting team. During the last few minutes, the presenting team will wrap up the discussion pointing out the generic similarities and differences across the examined sectors – in terms of the process of technological advance, firm characteristics, market structure, and user characteristics – that would be of interest to an economist trying to capture the essence of the underlying conditions to build generic models.

Team coalitions should emerge through self-selection. Presentation teams will be finalized during the class meeting of September 26.

iii. **Final examination.** The questions for the take-home final examination will be distributed during the last meeting of the class (December 7 – designated Monday). Your answers will be due a week later (December 14).
Basic Text

The following book provides the backbone for core sections of the course. It is highly recommended that you purchase it. It should be available at the University bookstore.


Further Important Reading Material

Several other books and monographs are excellent sources of information for various sections of the course. These books will not be available at the University bookstore. The instructor will provide access to the chapters from these books marked as “required reading” in the syllabus.


Finally, a number of additional readings are listed in the analytical course syllabus below.

The instructor will provide access to all required reading material (books and articles) and, upon request, to the supplementary, recommended material.
Schedule of Meetings and Readings
* Required reading

9/12
I. INTRODUCTION

A. Science and Technology in Economic Analysis

[1] “Introduction”

* Freeman, Chris and Luc Soete (1997) The Economics of Industrial Innovation, 3rd ed., The MIT Press. [Ch 1]
[1] “Introduction”

B. The Emergence of Systematic Industrial Innovation


Scotchmer, Suzanne (2005) Innovation and Incentives, The MIT Press. [Ch 1]
[1] “Institutions: A Brief Excursion through History”

II. THE NATURE OF INVENTION AND INNOVATION

9/19

A. Research and Development – Allocation of Resources


Scotchmer, Suzanne (2005) Innovation and Incentives, The MIT Press. [Chs 2, 8]
B. Agents and Process of Technological Advance


Scotchmer, Suzanne (2005) *Innovation and Incentives*, The MIT Press. [Ch 3]


III. MICROECONOMICS OF TECHNOLOGICAL ADVANCE

A. Background – Issues and Production Function


  [4] “Returns to Scale, Economies of Scale, Economies of Scope, and Learning”

B. Innovation, Firm Characteristics, Market Structure


* Freeman, Chris and Luc Soete (1997) *The Economics of Industrial Innovation*, 3rd ed., The MIT Press. [Ch. 9]
  [9] “Innovation and the Size of the Firm”
C. Technological Opportunity, Appropriability, Firm Strategy


Freeman, Chris and Luc Soete (1997) The Economics of Industrial Innovation, 3rd ed., The MIT Press. [Chs 8, 11]
[8] “Success and Failure in Industrial Innovation”


D. The Diffusion (Dissemination) of New Technology


Ruttan, Vernon W. (2001), Technology, Growth and Development, New York: Oxford University Press. [Ch. 5].
[5] “Technology Adoption, Diffusion and Transfer”


IV. RATES OF RETURN TO INVENTION / INNOVATION

A. On the Methodology of Measurement


B. Private Returns


C. Social Returns


D. Uncertainty, Project Evaluation


V. MACROECONOMICS OF TECHNOLOGICAL ADVANCE

11/7

A. Technology and Economic Growth


11/14

B. International Aspects: Technology Transfer, Trade, Multinationals


VI. SECTORAL SYSTEMS OF INNOVATION


A. Continuous Process Sectors

Power/Energy


Chemicals

[8] “Technical Change in the Chemical Industry”


Pharmaceuticals, Biotechnology


D. C. Mowery and R. R. Nelson (eds.) Sources of Industrial Leadership: Studies of Seven Industries. Cambridge, UK: Cambridge University Press.


11/28

B. Information Technology Sectors

Computers, Semiconductors


Software


*Internet, Mobile Communications*


12/5

*VII. THE ECONOMICS OF INFORMATION TECHNOLOGY*


12/7

*XIII. POLICY CONSIDERATIONS*

  [13] “Science and Technology Policy”


Freeman, Chris and Luc Soete (1997) The Economics of Industrial Innovation, 3rd ed., The MIT Press. [Chs 16-19]
  [16] “Aspects of Public Policy for Science, Technology and Innovation”
  [18] “Technology and the Environment”
  [19] “Conclusions: Beyond the Economics of Industrial Innovation”

Dec. 14 Final Examination Deadline

Note: Due to time limitations, the material on this syllabus does not cover comprehensively either all topics of interest to economists in the study of technological change or the available readings in each topic. For example, there is relatively little here on the formal industrial organization approach to R&D and technological innovation. You are very welcome to consult additional sources to cover various sections of the course, and strongly encouraged to do so in writing your term papers.
Possible Topic Areas for Survey Papers

1. Markets for Technology
   Reasons for failure and remedies – appropriability, spillovers (different kinds of) –
   technological opportunity – modern concepts of knowledge and technological knowledge
   communication (systems of innovation, networks).

2. Theory of the Firm
   Transaction costs – asset specificity – ownership – incomplete contracts for technology
   and opportunistic behavior – the boundaries of the firm: markets, hierarchies, and
   alternative (intermediate) organizational forms for promoting technological change and
   innovation.

3. Neo-Schumpeterian Hypotheses
   Schumpeter and his early followers – firm size and innovation – industry concentration
   and innovation – long stream of empirical evidence.

4. Industrial Expenditures on Research and Development
   Tournament models of R&D – non-tournament models of R&D – asymmetric models –
   uncertainty and factor indivisibilities – technology option models.

5. Returns to R&D: Private and Social
   R&D and productivity: empirical results and measurement issues – alternative research
   paradigms, including the production function model at the firm and industry levels –
   private returns – social returns – various kinds of knowledge and the size of the gap
   between private and social returns.

6. Technological Change and Industry Entry and Exit
   Entry and exit models – the role of small firms in innovation – industry evolution through
   time – technological change and industry evolution.

7. Industry Concentration
   Effect on the rate of technological advance – mergers – acquisitions – joint ventures –
   strategic alliances, definitions and structures – concentration measures – antitrust
   concerns – evolution of antitrust legislation in the US and the EU.

8. Intellectual Property Rights: Appropriating Knowledge
   The special role of IPRs in inducing innovation – various means for appropriating
   technological knowledge – the economics of the patent system – industry and regional
   differences – empirical results and case studies.

9. Technology Diffusion
   The diffusion process – contagion and the diffusion curve – the logistic and other
   theoretic models – factors influencing diffusion – estimation – firm and industry case
   studies.
10. Measurement of Technology and Innovation
Input indicators – output indicators – technology indicators – innovation indicators and two Oslo (OECD) manuals – historical evolution of indicator formation and links to theoretical developments – usefulness for research.

11. International Considerations, Technology Transfer
Multinational corporations (MNCs): theory and evidence – MNCs and technological advance in home countries – MNCs and technological advance in host countries – technology and international trade: main theoretical views and empirical evidence.