Economics of Technological Change and Innovation

Note Fall 2021: This course will be delivered in-person with online accommodations (permission required)

Introduction

This course provides an overview of important issues related to technological change and innovation 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 technological advancement and innovation. 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 advancement. 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 evolutionary processes involved in scientific and technological advancement. 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 learning 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 advancement 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 weighted 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 40%, in-class participation/presentation/on-time assignment completion for 30%, 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. If you do not have a topic, the instructor will give you one. 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. You need to submit an outline of the intended term paper by **September 20**. An approach that has worked well in the past for several course participants has been to critically survey the literature on particular subjects. Such surveys must consult much broader literature than present in our syllabus and synthesize it in a creative way. Examples of possible area topics are listed at the end of this syllabus. You are, however, free to venture outside this list. Deadline for term papers: **November 29**.

ii. **Class participation.** This refers to:
   (a) This portion of the grade is based on students’ attendance, frequency and quality of participation in class discussion. There are two components. First, active engagement in class discussions during lectures. Second, replying to a set of standard questions after each class lecture (posted on Blackboard).
   (b) The class meeting of **October 18** will be devoted to short presentations and discussion. Class participants will be divided into four teams, each responsible for a short presentation (20’) on a pre-assigned sector followed by 10’ Q&A. The purpose of the presentation will be to summarize the evolution of technological advancement in the respective sectors and the identification of important issues that would be of interest to economists dealing with systems of sectoral innovation.
   Team coalitions should emerge through self-selection. Presentation teams will be finalized during the third class meeting on **September 20**.

iii. **Final examination.** The questions for the take-home final examination will be distributed on **November 29**. Answers will be due a week later (**December 6**).

Out of Class and Independent Learning Expected per Week

For this 3-credit graduate class students are expected to spend at least **350 minutes** per week outside the classroom on preparation and class assignments.
Class Policies

Class attendance is expected. There will be no allowance for late work on assignments, except by prior arrangement with the instructor. The instructor has the discretion to grant or refuse requests for late work or make-up work. Students are always welcome to discuss grades with the instructor. However, students wishing to formally contest a grade are required to write a memo outlining their case, along with supporting examples from the submitted assignment.

University Policies & Services

Academic Integrity Code. Academic dishonesty is defined as cheating of any kind, including misrepresenting one's own work, taking credit for the work of others without crediting them and without appropriate authorization, and the fabrication of information. For details and complete code, see: studentconduct.gwu.edu/code-academic-integrity

Sharing of Course Content. Unauthorized downloading, distributing, or sharing of any part of a recorded lecture or course materials, as well as using provided information for purposes other than the student’s own learning may be deemed a violation of GW’s Student Conduct Code.

Use of Student Work (FERPA). The professor will use academic work that you complete during this semester for educational purposes in this course during this semester. Your registration and continued enrollment constitute your consent.

Accommodations for Students with Disabilities. Any student who may need an accommodation based on the potential impact of a disability should contact the Disability Support Services office at 202-994-8250 in the Rome Hall, Suite 102, to establish eligibility and to coordinate reasonable accommodations. For additional information see: disabilitysupport.gwu.edu/

Religious Observances. In accordance with University policy, students should notify faculty during the first week of the semester of their intention to be absent from class on their day(s) of religious observance. For details and policy, see: students.gwu.edu/accommodations-religious-holidays.

Mental Health Services 202-994-5300. The University's Mental Health Services offers 24/7 assistance and referral to address students' personal, social, career, and study skills problems. Services for students include: crisis and emergency mental health consultations confidential assessment, counseling services (individual and small group), and referrals. For additional information see: counselingcenter.gwu.edu/

GW Security and Safety Policy. In the case of an emergency, if at all possible, the class should shelter in place. If the building that the class is in is affected, follow the evacuation procedures for the building. After evacuation, seek shelter at a predetermined rendezvous location.
Readings

There is no single good textbook to cover all dimensions of this course. We will read only though one book in its entirety which you should purchase (very well priced):


The readings consist of articles from academic journals and chapters from other books and reports, referenced in detail below.

The instructor will provide access to all required reading material (book chapters and articles) and a significant part of the supplementary, recommended material through Blackboard.
# Summary Schedule of Class Meetings

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/30</td>
<td>INTRODUCTION: Science, Technology and Innovation in Economics</td>
</tr>
<tr>
<td>9/13</td>
<td>A. Allocation of Research Resources</td>
</tr>
<tr>
<td>9/20</td>
<td>B. Agents and Process of Technological Advancement [Deadline]</td>
</tr>
<tr>
<td>9/27</td>
<td>A. Innovation, Firm and Market Characteristics, Scale and Scope in R&amp;D</td>
</tr>
<tr>
<td>10/4</td>
<td>B. Firm Strategy, Technology Markets, Collaborative Networks</td>
</tr>
<tr>
<td>10/11</td>
<td>C. Technology Dissemination</td>
</tr>
<tr>
<td>10/18</td>
<td>D. Sectoral Systems of Innovation (in-class presentations)</td>
</tr>
<tr>
<td>10/25</td>
<td>E. Digital Economics / Economics of Artificial Intelligence / FinTech</td>
</tr>
<tr>
<td>11/1</td>
<td>A. Technology, Economic Growth, Productivity</td>
</tr>
<tr>
<td>11/8</td>
<td>B. Techno-economic Convergence / Catch-up / Middle-Income Trap</td>
</tr>
<tr>
<td>11/15</td>
<td>C. International Aspects, Trade</td>
</tr>
<tr>
<td>11/22</td>
<td>A. Measuring the Returns to R&amp;D</td>
</tr>
<tr>
<td>11/29</td>
<td>B. Automation and Jobs [Deadline]</td>
</tr>
<tr>
<td>12/6</td>
<td>C. Policy [Deadline]</td>
</tr>
</tbody>
</table>
Analytical Schedule of Class Meetings and Readings
Unmarked readings are required. An asterisk (*) denotes recommended reading

8/30

**INTRODUCTION: Science, Technology and Innovation in Economics**

[Ch 1] “The Nature and Importance of Innovation”

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

**I. THE NATURE OF INVENTION AND INNOVATION**

9/13

**A. Allocation of Research Resources**

[Ch 4] “Global R&D”
[Ch 5] “U.S. R&D Performance and Funding”
[Ch 6] “Global Science and Technology Capabilities”
https://ncses.nsf.gov/pubs/nsb20203/


9/20

**B. Agents and Process of Technological Advancement**

Schilling, Melissa A. (2020) *Strategic Management of Technological Innovation*, McGraw Hill. [Chs 2, 3]
[Ch 2] “Sources of Innovation”
[Ch 3] “Types and Patterns of Innovation”

* Tassey, Gregory (2007) *The Technology Imperative*, Edward Elgar. [Ch 7]
[Ch 7] “The Technology Life Cycle”

**Deadlines:** Term Paper Outline / Team Formation for Oct. 18 Group Presentation
II. MICRO & MESO ANALYSIS OF TECHNOLOGICAL CHANGE / INNOVATION

9/27

A. Innovation, Firm and Market Characteristics, Scale and Scope in R&D

[Ch 2] “Schumpeterian Hypotheses”
[Ch 3] “Empirical Studies of the Schumpeterian Hypotheses”

[Ch 3] “Competition and Innovation Basics: Arrow versus Schumpeter”


* Greenhalgh, Christine and Mark Rogers (2010), *op. cit.*, ch 5.
[Ch 5] “Innovative Firms and Markets”


10/4

B. Firm Strategy, Technology Markets, Collaborative Networks

Schilling, Melissa A. (2020), *op. cit.* [Chs 4, 5]
[Ch 4] “Standards Battles, Modularity, and Platform Competition”
[Ch 5] “Timing of Entry”


C. Technology Dissemination

[Ch 17] Hall, Bronwyn H. “Innovation and Diffusion”


Greenhalgh, Christine and Mark Rogers (2010), *op. cit.* [Ch 7]
[Ch 7] “Diffusion and Social Returns”

[Ch 11] "Factors Affecting the Diffusion of Technology"

Vonortas, Nicholas S. “Innovation Networks in Industry”

D. Sectoral Systems of Innovation (*in-class presentations*)

[Intro] “Sectoral Systems of Innovation: Basic Concepts”


Additional readings to be provided by the presenting teams

10/25  
E. Digital Economics / Economics of Artificial Intelligence / FinTech


III. MACROECONOMICS OF TECHNOLOGICAL CHANGE & INNOVATION

11/1  
A. Technology, Economic Growth, Productivity

Greenhalgh, Christine and Mark Rogers (2010), op. cit. [Ch 8] [Ch 8] “Models of Economic Growth”


11/8

**B. Techno-economic Convergence / Catch-up / Middle-Income Trap**


[Ch 1] “The Innovation Paradox”

[Ch 2] “The Nature of Innovation in Developing Countries”

[Ch 3] “The Innovation Paradox and the National Innovation System”


Lee, Jeong-Dong, Keun Lee, Dirk Meissner, Slavo Radosevic, and Nicholas S. Vonortas (eds) (2021) *The Challenges of Technology and Economic Catch-up in Emerging Economies*, Oxford University Press. [Chs 1, 4, 5, 7, 10]

[Ch 1] Lee, Jeong-Dong, Keun Lee, Dirk Meissner, Slavo Radosevic, and Nicholas S. Vonortas “Technology Upgrading and Economic Catch-Up: Context, Overview and Conclusions”

[Ch 4] Lee, Jeong-Dong, Chulwoo Baek, and Jung-In Yeon “Middle Innovation Trap: Capability Transition Failure and Stalled Economic Growth”

[Ch 5] Lee, Keun “Economics of Technological Leapfrogging”

[Ch 7] André Cherubini Alves, Nicholas S. Vonortas, and Paulo Antônio Zawislak “Macro and Micro Foundations for Technoogy Upgrading and Innovation: The Case of Shipbuilding and Offshore Industry in Brazil”

[Ch 10] Tilman Altenburg “Catching-up or Developing Differently? Techno-Institutional Learning with a Sustainable Planet in Mind”

C. International Aspects, Trade

Greenhalgh, Christine and Mark Rogers (2010), op. cit. [Ch 9]
[Ch 9] “Innovation and Globalization”

“Overview”
[Ch 1] “The New Face of Trade”
[Ch 2] “Drivers of Participation”

“Key Messages”
[Ch 1] “Global Investment Trends and Prospects”

IV. RETURNS TO R&D – EMPLOYMENT – POLICY

A. Measuring the Returns to R&D

[Ch 24] Hall, Bronwyn H., Jacques Mairesse and Pierre Mohnen “Measuring the Returns to R&D”

[Ch 3] R&D Portfolio Valuation and Formation
[Ch 4] Public Sector R&D Valuation: A Practical Example


* Several chapters of the book by Albert O. Link and Nicholas S. Vonortas (2013) are relevant (see book list at the end).

B. Automation and Jobs

West, Darrel M. (2019), op. cit. [Part II]


**Deadlines:** Term Paper Submission / Take-home Final Exam Distributed

12/6

C. Policy


Lee, Jeong-Dong, Keun Lee, Dirk Meissner, Slavo Radosevic, and Nicholas S. Vonortas (eds) (2021), *op. cit.* [Ch 15]

[Ch15] Carlo Pietrobelli “Industrial and Innovation Policies in a World of Global Value Chains”


[Ch 6] Trajtenberg, Manuel “Artificial Intelligence as the Next GPT: A Political-Economy Perspective”


West, Darrel M. (2019), *op. cit.* [Part III]

[Part III] “Is Politics Up to the Task?”, “Economic and Political Reform”


[Ch 11] “Some Concluding Remarks on Innovation-Centric Competition Policy”.


**Deadline:** Final Examination Answers Submitted
Examples Topic Areas for Survey Papers (indicative)

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

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 and Employment
Artificial intelligence, robotics, automation have raised important questions about the future of work.
10. Technology Diffusion

11. 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.

12. 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.

13. Industry Studies
Innovation across different industry sectors and subsectors such as information technology, robotics, pharmaceuticals, banking, agriculture etc. Role of technology platforms.

14. Technology, Energy, Environment
Choose subsectors to analyze in depth. Fossil, nuclear, renewables.
**Supplementary Reading (not part of the course)**

Several books offer excellent supplementary sources of information.


