THE GEORGE WASHINGTON UNIVERSITY
CCAS / ESIA
Department of Economics / Institute for International Science and Technology Policy

ECON 6255.80 / IAFF 6158.80
DUQUES 152
M 19:10 – 21:00
Fall 2021

Nicholas S. Vonortas
1957 E Str., N.W., Suite 401
Tel: (202) 378-6230
E-mail: vonortas@gwu.edu

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 19.
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: December 5.

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 17 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 19.

iii. ***Final examination***. The questions for the take-home final examination will be distributed on December 5. Answers will be due a week later (December 12).

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):

West, Darrel M. (2019) *The Future of Work*, Washington, D.C.: Brookings

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

8/29 INTRODUCTION: Science, Technology and Innovation in Economics

I. THE NATURE OF INVENTION AND INNOVATION

9/12 A. Allocation of Research Resources

9/19 B. Agents and Process of Technological Advancement [Deadline]

II. MICRO & MESO ANALYSIS OF TECHNOLOGICAL CHANGE / INNOVATION

9/26 A. Innovation, Firm and Market Characteristics, Scale and Scope in R&D

10/3 B. Firm Strategy, Technology Markets, Collaborative Networks

10/10 C. Technology Dissemination

10/17 D. Sectoral Systems of Innovation (in-class presentations)

10/31 E. Digital Economics / Economics of Artificial Intelligence / FinTech

III. MACROECONOMICS OF TECHNOLOGICAL CHANGE & INNOVATION

11/7 A. Technology, Economic Growth, Productivity

11/14 B. Techno-economic Convergence / Catch-up / Middle-Income Trap

11/21 C. International Aspects, Trade

IV. RETURNS TO R&D – EMPLOYMENT – POLICY

11/28 A. Measuring the Returns to R&D

12/5 B. Automation and Jobs [Deadline]

12/12 C. Policy [Deadline]

Analytical Schedule of Class Meetings and Readings

Unmarked readings are required. An asterisk (*) denotes recommended reading

8/29 *INTRODUCTION: Science, Technology and Innovation in Economics*

Greenhalgh, Christine and Mark Rogers (2010) *Innovation, Intellectual Property and Economic Growth*, Princeton University Press. [Ch 1]
[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

9/12 *A. Allocation of Research Resources*

National Science Board (2022) *The State of U.S. Science and Engineering 2022*, National Science Foundation.
https://ncses.nsf.gov/pubs/nsb20221/

Arrow, Kenneth (1962) "Economic welfare and the allocation of resources for invention," in Richard R. Nelson (ed.) *The Rate and Direction of Inventive Activity*, Princeton University Press.

Nelson, Richard R. (1959) "The simple economics of basic scientific research," *Journal of Political Economy*, June: 297-306.

9/19 *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. 17 Group Presentation

II. MICRO & MESO ANALYSIS OF TECHNOLOGICAL CHANGE / INNOVATION

9/26 *A. Innovation, Firm and Market Characteristics, Scale and Scope in R&D*

Kamien, Morton I. and Nancy L. Schwartz (1982) *Market Structure and Innovation,* Cambridge University Press. [Chs 2, 3]
[Ch 2] "Schumpeterian Hypotheses"
[Ch 3] "Empirical Studies of the Schumpeterian Hypotheses"

Gilbert, Richard J. (2020) *Innovation Matters: Competition Policy for the High-Technology Economy*, The MIT Press, Cambridge, MA. [Chs 3, 6]
[Ch 3] "Competition and Innovation Basics: Arrow versus Schumpeter"
[Ch 6] "Competition and Innovation: Empirical Evidence"

Lamoreaux, Naomi R. (2019) "The Problem of Bigness: From Standard Oil to Google", *Journal of Economic Perspectives*, 33(3): 94-117.

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

* Moraes Silva, Diego, Nicholas S. Vonortas, and Andre Furtado (2022) "Innovation Barriers, Indicators, and Policies: Coevolving Concepts in the History of Innovation Studies", *Annals of Science and Technology Policy*, 6(2): 100-227.

10/3 *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"

Acker, Olaf, Florian Groene, and Germar Schroeder (2016) "The New Game of Global Tech", *Strategy+Business*, PwC, 85: 1-15.

Economist (2018) "Taming the Titans" and "Coping with Techlash", *Briefing*, Jan. 20.

* Bloom, Nicholas and John Van Reenen (2007) "Measuring and Explaining Management Practices Across Firms and Countries", *Quarterly Journal of Economics*, CXXII(4): 1351-1408.

10/10 *C. Technology Dissemination*

Jan Fagerberg, David C. Mowery and Richard R. Nelson (eds) (2005) *The Oxford Handbook of Innovation*, Oxford University Press. [Ch 17]
[Ch 17] Hall, Bronwyn H. "Innovation and Diffusion"

Bloom, Nicholas, Tarek Alexander Hasan, Aakash Kalyani, Josh Lerner, and Ahmed Tahoun (2021) "The Diffusion of Disruptive Technologies", NBER Working Paper 28999.

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

Rosenberg, Nathan (1976) *Perspectives on Technology*, Cambridge University Press. [Ch 11]
[Ch 11] "Factors Affecting the Diffusion of Technology"

* Malerba, Franco and Nicholas S. Vonortas (eds) (2009) *Innovation Networks in Industries*, Cheltenham, UK: Edward Elgar. [Ch]
Vonortas, Nicholas S. "Innovation Networks in Industry"

10/17 *D. Sectoral Systems of Innovation (in-class presentations)*

Malerba, Franco (ed) (2004) *Sectoral Systems of Innovation*, Cambridge University Press. [Intro]
[Intro] "Sectoral Systems of Innovation: Basic Concepts"

* West, Darrel M. (2019) *The Future of Work*, Washington, D.C.: Brookings. [Part 1]
[Part 1] "Robots", "Artificial Intelligence", "The Internet of Things"

* Agrawal, Ajay, Joshua Gans, and Avi Goldfarb (eds) (2019) *The Economics of Artificial Intelligence*, NBER and The University of Chicago Press. [Ch 4]
[Ch 4] Cockburn, Iain M., Rebecca Henderson, and Scott Stern "The Impact of Artificial Intelligence on Innovation".

* Storey, Chris, Pinar Cankurtaran, Paulina Papastathopoulou, and Erik Van Hultink (2015) "Success Factors for Service Innovation: A Meta-Analysis", *Journal of Product Innovation Management*, 33(5): 527-548.

* Lakdawalla, Darius N. (2018) "Economics of the Pharmaceutical Industry", *Journal of Economic Literature*, 56(2): 397-449.

* Cornell University, INSEAD, and WIPO (2017) *The Global Innovation Index 2017: Innovation Feeding the World.* Ithaca, Fontainebleau, and Geneva.

* Cornell University, INSEAD, and WIPO (2018) *The Global Innovation Index 2018: Energizing the World with Innovation.* Ithaca, Fontainebleau, and Geneva.

* Cornell University, INSEAD, and WIPO (2019) *The Global Innovation Index 2019: Creating Healthy Lives—The Future of Medical Innovation*. Ithaca, Fontainebleau, and Geneva.

* De Rassenfosse, Gaetan, Dominique Foray et al. (2020) "COVID-19: Insights from Innovation Economists", *Research Paper*, College of Management of technology, Ecole Polytechnique Federale de Lausanne.

* Miles, Ian (2005) "Innovation in Services", in Jan Fagerberg, David C. Mowery and Richard R. Nelson (eds.) (2005), op. cit.

Asterisk readings indicative: Additional to be provided by the presenting teams

10/31 *E. Digital Economics / Economics of Artificial Intelligence / FinTech*

Varian, Hal, Joseph Farrell, and Carl Shapiro (2004) *The Economics of Information Technology*, Cambridge University Press.

Goldfarb, Avi and Catherine Tucker (2019) "Digital Economics", *Journal of Economic Literature*, 57(1): 3-43.

* U.S. House of Representatives, Subcommittee on Antitrust, Commercial and Administrative Law (2020) "Investigation of Competition in Digital Markets", Report.

III. MACROECONOMICS OF TECHNOLOGICAL CHANGE & INNOVATION

11/7 *A. Technology, Economic Growth, Productivity*

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

Agrawal, Ajay, Joshua Gans and Avi Goldfarb (eds) (2019), *op. cit*. [Ch 1]
[Ch 1] Brynjolfsson, Erik, Daniel Rock, and Chad Syverson "Artificial Intelligence and the Modern Productivity Paradox: A Clash of Expectations and Statistics"

Bloom, Nicholas, Charles I. Jones, John Van Reenen, Michael Webb (2020) "Are Ideas Getting Harder to Find?", *American Economic Review*, 110(4): 1104-1144.

* Yglesias, Matthew (2020) "The Tech Sector Is Finally Delivering on Its Promise", *Vox*, April 7.

* Roth, Felix (2019) "Intangible Capital and Labour Productivity Growth: A Review of the Literature", Report (Deliverable 2.1), GLOBALINTO, European Commission contract #822259).

11/14 *B. Techno-economic Convergence / Catch-up / Middle-Income Trap*

Cicera, Xavier and William F. Maloney (2017) *The Innovation Paradox: Developing Country Capabilities and the Unrealized Promise of Technological Catch-Up*, Washington, D.C.: World Bank. [ES & Chs 1-3]
"Executive Summary"
[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, Keun and Franco Malerba (2017) "Catch-Up Cycles and Changes in Industrial Leadership: Windows of Opportunity and Responses of Firms and Countries in the Evolution of Sectoral Systems", *Research Policy*, 46: 338-351.

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"

* Economist (2021) "The Prospects for Developing Countries Are Not What They Once Were", *Briefing*, July 31.

11/21 *C. International Aspects, Trade*

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

World Bank (2020) *World Development Report: Trading for Development in the Age of Global Value Chains*, Washington, D.C.: World Bank Group. [ES & Chs 1-2]
"Overview"
[Ch 1] "The New Face of Trade"
[Ch 2] "Drivers of Participation"

United National Conference on Trade and Development (2022) *World Investment Report 2022*, New York: UNCTAD. [ES & Ch 1]
[ES] "Key Messages"
[Ch 1] "Global Investment Trends and Prospects"

IV. RETURNS TO R&D – EMPLOYMENT – POLICY

11/28 *A. Measuring the Returns to R&D – Research Program Evaluation*

Hall, Bronwyn H. and Nathan Rosenberg (eds) (2010) *Handbook of the Economics of Innovation*, Volumes I and II, Elsevier. [Ch 24]
[Ch 24] Hall, Bronwyn H., Jacques Mairesse and Pierre Mohnen "Measuring the Returns to R&D"

Linquiti, Peter D. (2015) *The Public Sector R&D Enterprise: A New Approach to Portfolio Valuation*, Palgrave Macmillan. [Chs 3, 4]
[Ch 3] R&D Portfolio Valuation and Formation
[Ch 4] Public Sector R&D Valuation: A Practical Example

* Jones, Benjamin F. and Lawrence H. Summers (2020) "A Calculation of the Social Returns to Innovation", NBER Working Paper 27863, Cambridge, MA.

* Jaffe, Adam B. (2002) "Building Programme Evaluation Into the Design of Research-Support Programmes", *Oxford Review of Economic Policy*, Spring: 22-34.

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

12/5 *B. Automation and Jobs*

West, Darrel M. (2019), *op. cit*. [Part II]
[Part II] "Rethinking Work" "A New Social Contract", "Lifetime Learning"

Arthur, W. Brian (2017) "Where is Technology Taking the Economy?", *McKinsey Quarterly*, 1-11.

Arthur, W. Brian (2011) "The Second Economy?", *McKinsey Quarterly*, October 1-9.

* Lund, Susan et al. (2021) "The Future of Work After COVID-19", Report, McKinsey Global Institute, February.

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

12/12 *C. Policy*

Fagerberg, Jan (2016) "Innovation Policy: Rationales, Lessons, and Challenges", *Journal of Economic Surveys*, pp. 1-17.

Bloom, Nicholas, John Van Reenen, and Heidi Williams (2019) "A Toolkit of Policies to Promote Innovation", *Journal of Economic Perspectives*, 33(3): 163-184.

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"

Tartari, Valentina (2021) "More than an Ivory Tower: The Impact of Research Institutions on the Quantity and Quality of Entrepreneurship", NBER Working Paper 28846.

* Agrawal, Ajay, Joshua Gans, and Avi Goldfarb (eds) (2019), *op. cit*. [Ch6]
[Ch 6] Trajtenberg, Manuel "Artificial Intelligence as the Next GPT: A Political-Economy Perspective"

* Mani, Sunil (2021) "The Role of Industrial Policy in Market Friendly Economies: Case of COVID-19 Vaccine R&D and Its Manufacturing in India and the USA", *Commentary on India's Economy and Society's Series 21*, Centre for Development Studies, Kerala, India.

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

10. 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.

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.

1. Keun Lee, Jeong-Dong Lee, Slavo Radosevic, Nicholas S. Vonortas and Dirk Meissner (eds) (2021) *The Challenges of Technology and Economic Catch-Up in Emerging Economies*, Oxford University Press.

2. Bronwyn H. Hall and Nathan Rosenberg (eds) (2010) *Handbook of the Economics of Innovation*, Volumes I and II, Elsevier.

3. Albert O. Link and Nicholas S. Vonortas (eds) (2013) *Handbook on the Theory and Practice of Program Evaluation*, Edward Elgar Publishers.

4. Keun Lee (2019) *The Art of Economic Catch-Up: Barriers, Detours and Economic Leapfrogging in Innovation Systems*, Cambridge University Press.

5. Ajay Agrawal, Joshua S. Gans and Avi Goldfard (eds) (2019) *The Economics of Artificial Intelligence: An Agenda*, National Bureau of Economic Research.

6. Gustavo Crespi, Eduardo Fernandez-Arias and Ernesto Stein (eds) (2014) *Rethinking Productive Development: Sound Policies and Institutions for Economic Transformation*, Inter-American Development Bank.

7. Franco Malerba and Maureen McKelvey (2019) *Knowledge-Intensive Innovative Entrepreneurship*, NOW Press.

8. Faiz Gallouj and Faridah Djellal (eds.) (2010) *The Handbook of Innovation and Services*, Edward Elgar.

9. Jan Fagerberg, David C. Mowery and Richard R. Nelson (eds.) (2005) *The Oxford Handbook of Innovation*, Oxford University Press.

10. Chris Freeman and Luc Soete (1997) *The Economics of Industrial Innovation*, 3rd ed., The MIT Press.

11. Franco Malerba and Nicholas S. Vonortas (eds.) (2009) *Innovation Networks in Industries*, Edward Elgar.

12. Gerhard Rosegger (1996) *The Economics of Production and Innovation*, 3rd ed., Butterworth-Heinemann

13. Gregory Tassey (2007) *The Technology Imperative*, Edward Elgar.

14. Linquiti, Peter D. (2015) *The Public Sector R&D Enterprise: A New Approach to Portfolio Valuation*, Palgrave Macmillan.