

ASHISH ARORA

Ashish Arora is the Rex D. Adams Professor of Business Administration at the Fuqua School of Business at Duke University. He is a member of the strategy area, and associated with the Center for Entrepreneurship and Innovation, and is active in the Program for Entrepreneurs at the Fuqua School of Business. Arora received his Ph.D. in Economics from Stanford University in 1992, and was on the faculty at the Heinz School, Carnegie Mellon University, where he held the H. John Heinz Professorship, till 2009.

His research focuses on the economics of technology and technical change. Arora's research has included the study of technology intensive industries such as software, biotechnology and chemicals, the economics of information security, and the role of patents and licensing in promoting technology startups. He has studied the rise of the software industry and the pharmaceutical industry in emerging economies, especially in India. His current research focuses on the management of intellectual property and licensing in corporations, and innovation based entrepreneurship.

Arora's earlier research has been funded by the National Science Foundation and the Alfred P. Sloan Foundation, and he was the co-director of the Software Industry Center at Carnegie Mellon till 2006. His current research is supported by the National Science Foundation and the Kauffman Foundation. He has published three books, and nearly eighty articles and book chapters.

He serves as co-editor, *Research Policy*, and Associate Editor for *Management Science* and is on the editorial board of *Strategic Management Journal*, *Industrial and Corporate Change*, *Information Economics and Policy*, and *Journal of Evolutionary Economics*. In the past, he has served on advisory panels to the Secretary of Commerce, the National Academy of Sciences, and The Association for Computing Machinery. He was the distinguished speaker, Technology Management Section, for INFORMS, in 2006.

Arora has taught a variety of courses, including Economics of Information Security and Risk Management. He currently teaches Entrepreneurial Strategy for Innovation Based Ventures, and Emerging Markets Strategy.

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POSITIONS HELD

Rex D. Adams Professor of Business Administration, 2010--
Professor, Fuqua School, Duke University, 2009 --
Visiting Professor, Fuqua School, Duke University, 2008-2009.
H. John Heinz Professor, Heinz School, Carnegie Mellon, 2007 –2009
Professor, Heinz School, Carnegie Mellon University, June 2004 – 2009
Affiliated faculty, School of Computer Science, Carnegie Mellon University, 2001—2008
Co-Director, Software Industry Center, Carnegie Mellon University, May 2001 – June 2006.
Associate Professor, Heinz School, Carnegie Mellon University, June 1998 to June 2004
Assistant Professor, Heinz School, Carnegie Mellon University, August 1991-1998.

OTHER ACADEMIC AFFILIATIONS

Visiting professor, Bocconi University, Milan, June, 2010.
Research Associate, Productivity Program, National Bureau of Economic Research, 2008 –
Phillip Morris Visiting Professor, Scuola Santa'Anna, Pisa, June –Aug, 2004.
Visiting Associate Professor, Dept. of Economics, Stanford University, Jan - June 2002
Visiting Scholar, Center for Economic Policy Research, Stanford University, 1994-95

EDUCATION:

PhD, (Econ) Stanford University, January 1992.

MA (Econ) Jawaharlal Nehru University, Delhi, 1986.
BA (Econ) St. Stephen's College, Delhi University, Delhi, 1984.

PAPERS AND PUBLICATIONS

Books

- From Underdogs to Tigers? The Rise and Growth of the Software Industry in Brazil, China, India, Ireland, and Israel, (edited with Alfonso Gambardella), Oxford University Press, February, 2005. (Paperback edition issued September 2006.)
- Markets for Technology: The Economics of Innovation and Corporate Strategy, (with Andrea Fosfuri and Alfonso Gambardella), MIT Press, 2001. (Paperback edition issued 2004.)
- Chemicals and Long Term Economic Growth, editors, Ashish Arora, Ralph Landau, and Nathan Rosenberg, John Wiley and Sons, 1998. (Paperback edition issued 2000.)

Journal articles

1. "Securing their future? Entry and survival in the information security industry" (with Anand Nandkumar), *forthcoming*, **Strategic Management Journal**. (NBER WP 13634)
2. "Ideas for Rent: An Overview of Markets for Technology" (with Alfonso Gambardella), **Industrial and Corporate Change**. 2010 19: 775-803
3. "Complementarities and technology diffusion" (with Chris Forman and Jiwoong Yoon), **Information Economics and Policy**. 2010. 22(3): 228-242.
4. "An Empirical Analysis of Software Vendors' Patch Release Behavior Impact of Vulnerability Disclosure" (with Ramayya Krishnan, Rahul Telang and Yubao Yang"). **Information Systems Review**, 2010, 21(1).
5. "Competition and Patching of Security Vulnerabilities: An Empirical Analysis", (with Chris Forman, Anand Nandkumar and Rahul Telang). **Information Economics and Policy**. 2010. 22 (2): 164-177.
6. "Is the division of labor limited by the extent of the market? Evidence from the chemical industry" (with Jiwoong Yoon and Bill Vogt), **Industrial and Corporate Change**. 2009. 18(5): 785-806. (Lead Article)
7. "A breath of fresh air: Firm types, scale, scope and selection effects in drug development" (with Fabio Pammoli, Laura Magazzini and Alfonso Gambardella), **Management Science** 2009. 55(10): 1638-1653.
8. "R&D and the patent premium", (with Marco Ceccagnoli & Wesley Cohen), (revised version of NBER WP 9431) **International Journal of Industrial Organization**, 2008. 26 (5): 1153-1179.
9. "Optimal policy for software vulnerability disclosure", (with Rahul Telang and Xu Hao), **Management Science**, 2008. 54(4) 642:656.
10. "How local are IT outsourcing markets" (with Chris Forman), **Journal of Management Information Systems**. 2007. 24(2) 73-102.
11. "Open versus Closed firms and the Dynamics of Industry Evolution" (with Farasat Bokhari) **Journal of Industrial Economics**. 2007. 55(3) 499-527
12. "Effects of information revelation policies under market structure uncertainty" (with Amy Greenwald, Karthik Kannan, and Ramaya Krishnan), **Management Science**, 2007. 53(8), 1234-1248,
13. "Does Information Security attack frequency increase with Vulnerability disclosure? - An Empirical Analysis", (with Anand Nandkumar, Rahul Telang), **Information System Frontiers** 2006, 8:350-362.
14. "Profiting from licensing: The role of patent protection and commercialization capabilities", (with Marco Ceccagnoli), **Management Science**, 52(2), 293-308, 2006.
15. Response to comments on "Intellectual property rights, firm boundaries and R&D inputs" (with Robert Merges), **Industrial and Corporate Change** 2006. 15(6) 214-219.

16. "Sell first, patch later: Impact of patching on software quality" (with Jon Caulkins and Rahul Telang), **Management Science**, 2006. 52(3), 465-471.
17. "Pricing diagnostic information", (With Andrea Fosfuri), **Management Science**, 2005. 51(7): 1092-1100.
18. "The Impact of NSF Support for Basic Research in Economics", (with Alfonso Gambardella), **Annales d'Economie et de Statistique**. 2005. 79/80 of 2005 (Juillet-Décembre). (special issue in honor of Zvi Griliches)
19. "Economics of Software Vulnerability Disclosure" (with Rahul Telang), **IEEE Security & Privacy**, 2005, 3(1), 20-25.
20. "Measuring the Risk-Based Value of IT Security Solutions" (with Dennis Hall, Ariel Pinto, Dwayne Ramsey and Rahul Telang), **IEEE IT Professional** 2004. 6(6): 35-42.
21. "Intellectual property rights, firm boundaries and R&D inputs", (with Robert Merges), **Industrial and Corporate Change**, 2004. 13 (3): 451-475.
22. "Working through the patent problem" (with John Walsh and Wes Cohen), **Science**, 2003. 299(5609): 1021-1021, Feb 14.
23. "Licensing in the presence of competing technologies", (with Andrea Fosfuri), **Journal of Economic Behavior and Organization**, 2003. 52(2): 277-295.
24. "Markets for Technology in the Knowledge Economy", (With Andrea Fosfuri, Alfonso Gambardella), **International Social Science Journal**, 2002. 54 (1).
25. "The Software Industry and India's Economic Development", (With Suma Athreye), **Information Economics and Policy**, 2002. 14(2): 253-273.
26. "The Indian Software Services Industry: Structure and Prospects", (with V. S. Arunachalam, Jai Asundi and Ronald Fernandes), **Research Policy**, 2001. 30(8), 1267-1288.
27. "Markets for technology and corporate strategy", (with Alfonso Gambardella and Andrea Fosfuri), **Industrial and Corporate Change** 2001. 10(2): 419-451. (reprinted in Economics, Law and Intellectual Property Seeking Strategies for Research and Teaching in a Developing Field, Ove Granstrand (Ed.) 2004, Springer.)
28. "IBIZA: E-market Infrastructure for Custom-built Information Products", (with Greg Cooper, Ramayya Krishnan, and Rema Padman), **Information System Frontiers**, 2000. 2(1): 65-84.
29. "Exploring the internalization rationale for international investment: Wholly owned subsidiary versus technology licensing in the worldwide chemical industry", (with Andrea Fosfuri), **Journal of International Business Studies**. 2000. 31(4) 555-572.
30. "Measuring the readiness cost of 'one-size-fits-all' public policy" (with Joe Besselman and Pat Larkey), **Acquisition Review Quarterly**, 2000. 7(4): 295-310.
31. "The Market for Technology in the Chemical Industry: Causes and Consequences", (with Andrea Fosfuri), **Revue d'Economie Industrielle**, 2000. 92, 317-334. (Reprinted in The Economics of Contracts, 2002, Eric Brousseau and Jean-Michael Glachant (eds), Cambridge University Press, Cambridge UK.)
32. "Specialized Technology Suppliers, International Spillovers and Investment: Evidence from the Chemical Industry", (with Alfonso Gambardella, and Andrea Fosfuri), **Journal of Development Economics**, 2000. 65(1): 31-54.
33. "Purchasing Performance: A public versus private sector comparison of commodity buying", (with Joe Besselman and Patrick Larkey), **Acquisition Review Quarterly**, 1999. 6(4): 333-354.

34. "Buying in a businesslike fashion: And paying more?", (with Joseph Besselman and Patrick Larkey), **Public Administration Review**, 1999. 60(5): 421-434.
35. "Enter at your own risk: HMO participation and enrollment in the Medicare risk market" (with Jean Abraham, Martin Gaynor and Doug Wholey), **Economic Inquiry**, 1999. 38(3): 385-401.
36. Returns to scientific reputation: Funding of Research Projects by the Italian CNR", (with Alfonso Gambardella and Paul David), **Les Annales des Economie et des Statistiques**, 1998. No. 49/50, 164-198.
37. "Patents, Licensing, And Market Structure In Chemicals", **Research Policy**, 1997. 26: 391-403.
38. "Domestic Markets And International Competitiveness: Generic and Product-Specific Competencies in the Chemical Engineering Sector", (with Alfonso Gambardella), **Strategic Management Journal**, 1997. 18 (Summer Special Issue), 53-74.
39. "Division of Labour and the Locus of Inventive Activity", (with Alfonso Gambardella and Enzo Rullani), **Journal of Management and Governance**, 1997, Vol. 1, 123-140.
40. "Public Policy Towards Science: Picking Stars or Spreading the Wealth?", (with Alfonso Gambardella) in **Revue d'Economie Industrielle**, (Special Number, "The Economics of Science) 1997, No. 79. 63-76.
41. "Contracting for Tacit Knowledge: The Provision of Technical Services in Technology Licensing Contracts", **Journal of Development Economics**, 1996. 50(2): 233-256.
42. "The Role Of Institution-Building In U.S. Industrial Modernization Programs", (with Maryellen Kelley), **Research Policy**, 1996. 25(2): 265-279.
43. "Testing For Complementarities In Reduced Form Regressions", **Economics Letters**, 1996. 50(1): 51-55.
44. "Licensing Tacit Knowledge: Intellectual Property Rights And The Market For Know-How", **Economics of Innovation and New Technology**, 1995. 4(1): 41-60.
45. "Evaluating Technological Information And Utilizing It: Scientific knowledge, technological capability, and external linkages in biotechnology." (With Alfonso Gambardella), **Journal of Economic Behavior and Organization**, 1994. 24(1): 91-114.
46. "The Changing Technology of Technological Change" (With Alfonso Gambardella), **Research Policy**, 1994. 23(5): 523-532.
47. "Complementarities And External Linkages: The strategies of large corporations in biotechnology", **The Journal of Industrial Economics**, 1990. 38(4): 361-379. (With Alfonso Gambardella.) (Translated and reprinted in Economia e Politica Industriale, n. 65, 1990, 71-94.)

Book Chapters and other publications

1. "Human capital and the Indian software industry" (with Surendra Bagde) in Krishnendu Ghoshdastidar (ed). Essays in Honour of Professor Anjan Mukhejee", Oxford University Press. *Forthcoming*. (Revised version of *NBER working paper*, 16167.)
2. "Implications for Energy Innovation from the chemical industry" (with Alfonso Gambardella), in Rebecca Henderson and Richard Newell (eds), Accelerating Energy Innovation: Lessons from Multiple Sectors, 2010, National Bureau of Economics Research. (earlier version *NBER wp 15676*)
3. "The market for technology" (with Alfonso Gambardella), in The Handbook of Economics of Technical Change, Bronwyn H. Hall, and Nathan Rosenberg (eds.), 2010, North-Holland, Elsevier Press, Amsterdam and Oxford.
4. "The extent of globalization of software innovation" Communications of the ACM Volume 52 , Issue 2 February 2009. (With Chris Forman and Matej Drev).
5. "The chemical industry" in The New Palgrave: A Dictionary of Economics, 2nd Edition. Steve Durlauf and Lawrence Bloom, (eds.), McMillan Press, 2008.

6. "The Indian software industry and its prospects", 2008, in Sustaining India's Growth Miracle, Jagdish Bhagwati and Charles Calomiris (eds), Columbia Business School Press, New York City, NY 2008.
7. "Patents and the market for technology", (with Alfonso Gambardella and Andrea Fosfuri) in Keith Maskus (ed.) 2008 Intellectual Property Rights, Growth and Trade, 123-156, Elsevier Press, Amsterdam and Oxford.
8. Software. (with Chris Forman, and Jiwoong Yoon). In J.T. Macher and D.C. Mowery, Eds., Innovation in Global Industries: U.S. Firms Competing in a New World. National Academies Press, Washington, D.C., 2008, 53--99.
9. "Markets for technology, intellectual property rights and development" (with Andrea Fosfuri and Alfonso Gambardella) in Keith E. Maskus and Jerome H. Reichman, eds, International Public Goods and Transfer of Technology under a Globalized Intellectual Property Regime (CUP), 2005. 321-336
10. "Trading knowledge: Exploring the determinants of market transactions in technology and R&D", (with Marco Ceccagnoli and Wes Cohen), in Lamareux and Sokoloff (eds.) Financing Innovation in the United States, MIT Press, Cambridge, MA, 2007:365-404.
11. "Emerging issues in the new economy and globalization" (with Alfonso Gambardella), in Patrizio Bianchi and Sandrine Labory (eds.) International Handbook on Industrial Policy, Edward Elgar, Cheltenham and Northampton, 2006: 28-44.
12. "The emerging offshore software industries and the United States" in Lael Brainard and Susan Collins (eds.), Brookings Trade Forum 2005, 2006, Brookings Press, DC.
13. "A Value-Based Approach to Predicting System Properties from Design" (with Scaffides, Butler and Shaw), International Workshop on Economics-Driven Software Engineering Research, 2005, St. Louis.
14. "The Globalization of the Software Industry: Perspectives and Opportunities for Developed and Developing Countries", (with Alfonso Gambardella), in Jaffe, A., Lerner, J., and Stern, S., (eds.) Innovation Policy and the Economy, Vol 5, MIT Press, 2005. (revised version of NBER WP 10538).
15. "In the footsteps of the Silicon Valley? Indian and Irish software in the international division of labor", (with Alfonso Gambardella and Salvatore Torrissi), in Building High-Tech Clusters, Tim Bresnahan and Alfonso Gambardella (eds), Cambridge University Press, 2004.
16. "Corporate restructuring and R&D: a panel data analysis for the chemical industry" (with Marco Ceccagnoli and Marco Darin), in R&D, Innovation and Competitiveness in the European Chemical Industry, Cesaroni et al. (Eds.), 2004, Springer.
17. "Research tool licensing and patenting and biomedical innovation" 2003, (with John Walsh and Wesley Cohen), in Wesley Cohen and Steve Merrill (eds), Patents in the Knowledge Based Economy, NAS Press, Washington DC.
18. "Synthetic Fibers Industry", 2003, in The Oxford Encyclopedia of Economic History, Joel Mokyr (ed) (with Ralph Landau).
19. "Chemicals", (with Ralph Landau) in William Lazonick (Ed.) IEBM Handbook of Economics, 2002, Thompson Business Press, London.
20. "Introduction" in Measuring the payoff from chemical research, Council on Chemical Research, 2001.
21. "Software development in non-member countries: The Indian case", in OECD Information Technology Outlook, OECD, Paris, 2000.
22. "The dynamics of industry structure: The chemical industry in the US, Western Europe, and Japan in the 1980s" (with Alfonso Gambardella), in J. Lesch (ed.) The German Chemical Industry in the Twentieth Century, Dordrecht, The Netherlands: Kluwer Academic Publishers, 2000, 407-440.
23. "Dynamics of comparative advantage in the chemical industry", (with Nathan Rosenberg and Ralph Landau), in Sources of Industrial Leadership, David Mowery and Richard Nelson (eds.) Cambridge University Press, 1999.
24. "The Chemical Industry: From the 1850s until today", (with Ralph Landau), Business Economics, vol 34, no 4, 7-14, 1999.
25. "Chemicals" (with Alfonso Gambardella) in David Mowery (ed.), U.S. Industry in 2000: Studies in Competitive Performance, National Research Council, National Academy Press, 1999.

26. "The U.S. success story: The growth of the United States chemical industry", (with Nathan Rosenberg), in Chemicals and Long Term Economic Growth, Ashish Arora, Ralph Landau, and Nathan Rosenberg (eds.), John Wiley and Sons, 1998.
27. "Evolution of industry structure in the chemical industry" (with Alfonso Gambardella), in Chemicals and Long Term Economic Growth, Ashish Arora, Ralph Landau, and Nathan Rosenberg (eds.), John Wiley and Sons, 1998.
28. "Division of Labor in Biotechnology". (With Alfonso Gambardella.), in Annetine Gelijns, and Nathan Rosenberg (eds.), Sources of Medical Technology: Universities and Industry, 1995, National Academy Press.
29. "Appropriating Rent From Innovation: A Historical Look At The Chemical Industry", in Horst Albach and Stephanie Rosenkranz (eds) Intellectual Property Rights and Global Competition, 1995, Verlag, Berlin.

Book Reviews

1. "Shaping the twentieth century: The remarkable story of the evolution of the modern chemical and pharmaceutical industries." By Alfred D. Chandler, Jr. Harvard University Press. For **Journal of Economic Literature**, 2006), 66: 266-268 Cambridge University Press
2. "The Free-Market Innovation Machine: Analyzing the Growth Miracle of Capitalism", William J. Baumol, in **Journal of Technology Transfer**, 2003 (28), 179-81.
3. "Inventing the Internet", Jane Abbate, **Journal of Economic Literature**, 38 (4): 971-972 2000
4. "Entrepreneurship, Small and Medium Sized Enterprises and the Macroeconomy", Acs et al. (eds.), **Journal of Technology Transfer**, 25:89-102, 2000.
5. "Innovation and industry evolution" by David B. Audretsch, **Journal of Economic Behavior and Organization**, 33(1), May 1997.
6. "Market Structure, corporate performance, and innovative activity", Paul Geroski, in **Journal of Economic Literature**, June, 1996 (2).
7. "Technology and the Wealth of Nations", 1992, Freeman, C., and Foray, D. (eds.), in **Finance and Development**, 1994.

Unpublished working papers and manuscripts under preparation

1. "The organization of R&D in American Firms: Determinants and Consequences", 2011 (with Sharon Belenzon and Luis Rios). *Under preparation*.
2. "Cash-out or flame out! Entrepreneurial opportunity cost and outcomes" (with Anand Nandkumar), **NBER WP 15532. R&R, Management Science**
3. "Managing licensing in a market for technology" (with Andrea Fosfuri and Thomas Roende). **R&R, Management Science**.
4. "Going soft: how the rise of software based innovation led to the decline of Japan's IT industry and the resurgence of Silicon Valley" (with Lee Branstetter and Matej Drev), 2010. **NBER working paper, 16156. R&R, Review of Economics and Statistics**
5. "Does in-house R&D increase bargaining power in licensing: Evidence from the pharmaceutical industry", (With Fabio Pammoli, Bill Vogt and Jiwoong Yoon). *Heinz School Working Paper*.
6. "Fundamental patent reform and returns to R&D: The case of the Indian pharmaceutical industry", (with Lee Branstetter and Chirantan Chatterjee), *under preparation*.
7. "Optimal bidding in online sequential auctions: Evidence from e-Bay auctions" (with Rema Padman, Bill Vogt and Hao Xu). *Working paper*, Heinz School.
8. "Coordination and decision making in a market with uncertainty" (with V Choudhary, Karthik Kannan, Ramaya Krishnan, and Rema Padman). *Working paper*, Heinz School.
9. "Quality Certification and the Economics of Contract Software Development", (With Jai Asundi), 1999, **NBER working paper 7260**, Heinz School WP, 99-14.

COMMISSIONED REPORTS

“The Indian software industry” (With V S Arunachalam, Jai Asundi and Ronald Fernandes), submitted to the Sloan Foundation, June 2000.

"Evaluating the impact of NSF funding for basic research in economics", submitted to the NSF, Aug, 1996.

"Towards a National System of Industrial Modernization Services", (with Maryellen Kelley), submitted to the National Institute of Standards and Technology, 1993.

Professional Service

Editor, Research Policy 2009 --

Associate Editor, Management Science (Entrepreneurship and Innovation); Industrial and Corporate Change

Associate Editor, Management Science (Public Sector Applications; Information systems) 2006-2009.

Editorial Board, Strategic Management Journal, Information Economics and Policy, Journal of Management and Governance, Journal of Evolutionary Economics

Member, *Measuring Innovation in the 21st Century Economy Advisory Committee to Secretary of Commerce*, Dec 06 – Dec 08.

Member, Project on Competitiveness and Workforce Needs of U.S. Industry, Board on Science, Technology and Economic Policy, National Academy of Sciences, March 2006 -- 2008.

Member, *Committee on Globalization of Materials Research and Development*, National Research Council, National Academy of Sciences, NMAB, Jan 2004 – Aug 2005..

Member, *Committee on Intellectual Property Rights in Genomic and Protein-Related Inventions*, National Research Council, National Academy of Sciences, STEP Board, Feb 2004 — Nov 2005.

Member, *Job Migration Task Force*, Association for Computing Machinery, August 2004—2006

Ad hoc reviewer or panel member for (last 5 years)

National Science Foundation, National Institutes of Health, Academy of Management, BPS; Italian Ministry of Education and Research, RAND Journal of Economics, Management Science, Review of Economics and Statistics, Journal of Economic Behavior and Organization, Journal of Industrial Economics, International Journal of Industrial Economics, Economics of Innovation and New Technologies, Research Policy, Strategic Management Journal, Information Technology and Management, Journal of Management and Governance, Organization Science, Decision Support Systems, Journal of Institutional and Theoretical Economics, Journal of International Business Studies, Edward Elgar Press, John Wiley and Sons, Oxford University Press.