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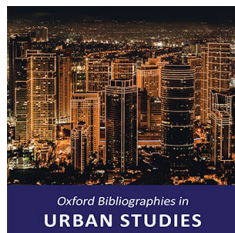
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Urban Innovation Systems

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Introduction

There are good reasons to study urban innovation from a systemic perspective. A key finding in innovation research is that organizations rarely innovate in isolation, but in interaction with clients, competitors, suppliers, and other organizations. A system perspective is useful in understanding and analyzing these interactions. Cities and urban regions are increasingly recognized as key milieus in which these interactions occur. The urban innovation system approach conceptualizes the city or urban region as a context in which innovations emerge from complex interactions between urban actors—firms, citizens, governments, knowledge institutes—in a particular institutional setting. The systemic view of innovation departs from traditional linear models that depict innovation as a staged process that starts with (basic) scientific research and ends with commercialization by companies. Innovation processes are much more complex and diverse, influenced by multiple actors that interact in networks with feedback loops, and involving many types of knowledge beyond scientific knowledge. Urban innovation systems are nested in innovation systems on other spatial levels—regional, national, international. Studies on urban innovation systems seek to explain how innovations emerge in an urban context, why urban regions differ in their innovative performance, and also address questions on the governance and management of such systems. Studies in this field draw from a variety of disciplines including economic geography, urban and regional economics, political sciences, innovation studies, social sciences, and urban planning.

General Overviews

A good starting point for understanding urban innovation systems is the seminal book Hall 1998, which elaborates how, throughout human history, cities have played a key role as innovation breed-beds, magnets for talent where talented entrepreneurs, scientists, artists, cultural innovators, and capitalists mutually reinforce each other. Another classic is Jacobs 1969, which provides a powerful argument linking diversity (cultural, economic, and architectural) to innovation and prosperity. Jacobs's systemic view led her to reject massive grand urban designs planned to "modernize" cities by bulldozing away old neighborhoods and replacing them with modern blocks and broad highways. The premodern urban neighborhoods that she cherished are now the main cradles of creative and innovative activity in many cities. In a more precise conceptualization, Cooke, et al. 1997 specifies the concepts of "region," "innovation," and "system," and identifies the organizational and institutional dimensions of local innovation systems. Fagerberg, et al. 2006 dedicates several chapters to the systemic nature of innovation and the role of regions and cities. A systemic approach to innovations can also be found in the literature on creative cities like Landry 2012 and Scott 2006. Simmie 2001 explores the link between geography and innovation, and presents in-depth case studies on innovation in Stuttgart, Milan, Paris, London, and Amsterdam, elaborating on how urban assets contribute to innovation. Van Winden, et al. 2014 provides a broad and recent overview on the literature of urban innovation systems, and also addresses the question to what extent such systems can be managed. In the early 21st century, the term "innovation ecosystem" has become more popular than urban innovation system; Oh, et al. 2016 is critical of using this term, rejecting it as not yet a clearly defined concept, much less a theory. Moreover, in the authors' view the idea carries pitfalls, notably its overemphasis on market forces, and its flawed analogy to natural ecosystems.

Cooke, Philip, Mikel Gomez Uranga, and Goio Etxebarria. "Regional Innovation Systems: Institutional and Organisational Dimensions." *Research Policy* 26.4–5 (1997): 475–491.

Specifies the concepts of "region," "innovation," and "system" as the prelude to an extended discussion of the importance of financial capacity, institutionalized learning, and productive culture to systemic innovation. Building on the notion of regions as occupying different positions on a continuum and referring to processes constituting them and their powers vis-à-vis innovation policy, the paper concludes by advocating strengthening of region-level capacities for promoting both systemic learning and interactive innovation.

Fagerberg, Jan, David C. Mowery, and Richard R. Nelson, eds. *The Oxford Handbook of Innovation*. New York: Oxford University Press, 2006.

Contains a broad overview of innovation studies literature, including reflections on the role of cities and regions.

Hall, Peter Geoffrey. *Cities in Civilization*. New York: Pantheon Books, 1998.

Analyzes twenty-one cities at their greatest moments in history, outlining the forces that led to each city's success. Hall identifies four distinct expressions of urban innovation: artistic growth, technological progress, the marriage of culture and technology, and the assemblage of solutions to problems. Cases include Renaissance Florence, Manchester during the Industrial Revolution, Henry Ford's Detroit, and Palo Alto at the dawn of the computer age.

Jacobs, Jane. *The Economy of Cities*. New York: Vintage, 1969.

Stresses localized entrepreneurship as major source of innovation and wealth. Jacobs describes vividly how, throughout different times and places, cities grow in wealth and importance on a wave of innovations generated by local entrepreneurs, and sink back when diversity wanes and cities become dominated by a single industry or oligopoly.

Landry, Charles. *The Creative City: A Toolkit for Urban Innovators*. 2d ed. New York: Routledge, 2012.

Provides an overview of creative cities and delivers a range of approaches and methods for city stakeholders to think creatively, to plan creatively, and to act creatively in order to arrive at urban innovations.

Oh, Deog-Seong, Fred Phillips, Sehee Park, and Eunghyun Lee. "Innovation Ecosystems: A Critical Examination." *Technovation* 54 (2016): 1–6.

Reviews the increasingly popular concept of innovation ecosystems and asks "What is gained from adding 'eco-' to the treatment of national and regional innovation systems?" (p. 1).

Scott, Allen J. "Creative Cities: Conceptual Issues and Policy Questions." *Journal of Urban Affairs* 28.1 (2006): 1–17.

A critical overview of the interactions between urbanization and creativity. Allen highlights positive and negative tendencies related to the emergence of creative cities.

Simmie, James, ed. *Innovative Cities*. London: Spon Press, 2001.

This book starts with a rich introduction into the history of ideas on the urban geography of innovation, from Schumpeter to Porter. It includes an in-depth analysis of five European case studies (Amsterdam, London, Milan, Paris, and Stuttgart). Among many other things, the cases reveal the importance of path dependency of urban innovation and a city's position in national urban systems as key context variables.

van Winden, Willem, Erik Braun, Alexander Otgaar, and Jan-Jelle Witte. *Urban Innovation Systems: What Makes Them Tick?* New York: Routledge, 2014.

After a broad literature review, the authors take a policy perspective, analyzing which factors play a role in managing or steering urban innovation systems in various national contexts.

Journals

Many journals publish work on urban innovation systems. Leading journals with papers that take an urban perspective on innovation are *Cities*, *Urban Studies*, *Regional Studies*, *Journal of Economic Geography*, *Journal of Urban Technology*, and *European Urban and Regional Studies*. Leading journals that primarily focus on innovation studies (where the urban dimension is the context in which systemic innovation takes place) are *Research Policy*, *Journal of Business Venturing*, *Journal of Technology Transfer*, and *Technovation*. All of these journals are peer reviewed and widely respected.

***Cities*. 1983–.**

Cities offers a comprehensive range of articles on all aspects of urban policy. Recently, it has published a special issue, *Creative Cities after the Fall of Finance* (33, 2013) and another volume with a special section on Smart Cities (78, 2018).

***European Urban and Regional Studies*. 1994–.**

This journal explores how place, space, and scale make a difference to the cultural, economic, social and political map of Europe.

***Journal of Business Venturing*. 1985–.**

This journal publishes entrepreneurship research from the disciplines of economics, psychology, and sociology; it has many contributions that take an urban-systemic view on entrepreneurship and innovation.

***Journal of Economic Geography*. 2001–.**

The aims of the *Journal of Economic Geography* are to redefine and reinvigorate the intersection between economics and geography. It offers a wide variety of theoretical and empirical contributions on Clusters, innovation networks, value chains, and other topics related to the geography of innovation.

***Journal of Technology Transfer*. 1977–.**

This journal publishes research on management practices and strategies for technology transfer, including the role of the external environment affecting these practices and strategies and related public policy developments, regulatory and legal issues, and global trends.

***Journal of Urban Technology*. 1992–.**

This journal publishes articles that review and analyze developments in urban technologies as well as articles that study the history and the political, economic, environmental, social, aesthetic, and ethical effects of those technologies.

***Regional Studies*. 1967–.**

This journal publishes research that distills how economic and political processes and outcomes are contingent upon regional and local circumstances. The journal is a pluralist forum, which showcases diverse perspectives and analytical techniques. Frequently, it publishes special issues related to the field of urban innovation systems, such as innovation and geographical spillovers "*Innovation and Geographical Spillovers*" (52.5, 2018); knowledge flows, externalities, and innovation networks "*Knowledge Flows, Externalities and Innovation Networks*" (51.8, 2017); and "*From 'Territorial Innovation Models' to 'Territorial Knowledge Dynamics'*" (50.2, 2016).

***Research Policy*. 1971–.**

Research Policy articles examine empirically and theoretically the interaction between innovation, technology, or research on the one hand, and economic, social, political, and organizational processes on the other. The urban-spatial context is explicit in many papers. The journal has published widely on environmental innovations in cities, local innovation and cluster policies, and procurement for innovation.

Technovation. 1981–.

This interdisciplinary journal encompasses all facets of technological innovation. Innovation is considered from the perspectives of process and product, social innovations (regulation and policy as well as creation of noneconomic benefit), and conceptualization of a new technology-based product or process through commercial utilization. The journal publishes regularly on topics such as business incubation, sustainability Transitions, and innovation ecosystems and their urban-spatial dimensions.

Urban Studies. 1964–.

This journal welcomes submissions that further our understanding of the urban condition and the rapid changes taking place in cities and regions across the globe, whether from an empirical, theoretical, or a policy perspective. In recent years, special issues have appeared on urban energy transitions, smart cities, urban networks, and network theory.

Systems of Innovation

Literature on urban innovation systems can be considered as a special strand within the wider literature on the systemic nature of innovation. The innovation system concept was developed in parallel at different places in Europe and in the United States in the 1980s. The main thread of this literature is to explain how structural conditions and factors in countries or regions—infrastructures, networks, institutions, policy frameworks—affect business innovation, and to understand why the economies of nations, regions, or sectors differ in their innovation performance. It emphasizes interlinkages between elements, and tends to consider innovation as a coevolutionary process. Lundvall 2007 provides an overview of the emergence and development of the national systems of innovation concept. The author, together with Christoffer Freeman (see Freeman 1995), is one of the pioneers in the field. There is an ongoing debate about the main arena in which systemic innovation takes place: the national level (Lundvall 2007); the sectoral level (Breschi, et al. 2000); or the regional and urban level (Cooke, et al. 1997). Regarding the latter (urban) regions, those within nations can also display distinct or “idiosyncratic” systems of innovation which depart from the national norm and can in turn be different from other regions, as Howells 2002 demonstrates. Other key sources on the geography of innovation from a systemic perspective are Feldman 1993 (a conceptual paper) and Storper 1997. As urban innovation systems are complex and highly contextual, case studies are a widely used research method for capturing this richness and complexity. Good case studies are insightful because of their full and detailed accounts of relevant events and factors, but can always be criticized for their lack of generalizability to other city regions. The literature offers many insightful individual case studies, most of them unraveling the exceptional stories of well-known innovative regions, including the classic account of Silicon Valley’s regional innovation networks, Saxenian 2000. Castells and Hall 1994 is an example of a multiple case study, where authors analyze cases to derive generalized notions and theory about the nature of urban innovation systems. Others start with a specific theoretical lens to compare cases with each other, as when Kenney and von Burg 1999 compares Silicon Valley with Route 128, building on path-dependent and dominant design explanations of technical and industrial change. Doloreux 2003 focuses on territorial innovation systems in peripheries, analyzing the case of Beauce in Quebec.

Breschi, Stefano, Franco Malerba, and Luigi Orsenigo. “Technological Regimes and Schumpeterian Patterns of Innovation.” *The Economic Journal* 110.463 (2000): 388–410.

Defines a sectoral system of innovation as a group of related firms active in developing and producing a sector’s products and in generating and utilizing a sector’s technologies. Firms are related through processes of interaction and cooperation in artefact-technology development and through processes of competition and selection in innovative and market activities.

Castells, Manuel, and Peter Hall. *Technopoles of the World: The Making of 21st-Century Industrial Complexes*. London and New York: Routledge, 1994.

Contains detailed case studies on the development of technopoles (science parks, science cities, national technopoles, and technobelt programs) including Silicon Valley, Siberia, Sophia Antipolis, and the M4 Corridor to Taiwan. It sketches their development and achievements, and draws lessons and guidelines for national, regional, and local planners.

Cooke, Philip, Mikel Gomez Uranga, and Goio Etxebarria. "Regional Innovation Systems: Institutional and Organisational Dimensions." *Research Policy* 26.4–5 (1997): 475–491.

While acknowledging the contribution of research to national innovation systems, the authors complement the national focus with a subnational (regional or urban) one, for conceptual and methodological reasons. Taking an evolutionary economics standpoint, the authors advocate the strengthening of region-level capacities for promoting both systemic learning and interactive innovation.

Doloreux, David. "Regional Innovation Systems in the Periphery: The Case of the Beauce in Quebec (Canada)." *International Journal of Innovation Management* 7.1 (2003): 67–94.

Based on a survey of forty-five SMEs in a rural region in Quebec, this paper studies how innovation occurs in peripheral regions. It investigates firms' actual innovation activities and capabilities, and finds specific factors affecting their innovation activities.

Feldman, Maryann P. "An Examination of the Geography of Innovation." *Industrial and Corporate Change* 2.3 (1993): 451–470.

This conceptual paper suggests that spillovers are geographically mediated. It develops a model that relates the concentration of innovative activity (in manufacturing) to the presence of a set of innovative inputs: university R&D, industrial R&D, related industries, and specialized business services.

Freeman, Chris. "The 'National System of Innovation' in Historical Perspective." *Cambridge Journal of Economics* 19.1 (1995): 5–24.

Provides an historical perspective on innovation systems. Recognizing the growth of international connectedness, the author underlines the continuing strong influence of national factors such as education systems, industrial relations, technical and scientific institutions, government policies, and cultural traditions.

Howells, Jeremy R. L. "Tacit Knowledge, Innovation and Economic Geography." *Urban Studies* 39.5–6 (2002): 871–884.

Discusses the relevance of tacit knowledge in innovation processes, how geographical location influences the link between knowledge and innovative activity, and the influence of tacit knowledge on the geography of innovation and economic activity.

Kenney, Martin, and Uris von Burg. "Technology, Entrepreneurship and Path Dependence: Industrial Clustering in Silicon Valley and Route 128." *Industrial and Corporate Change* 8.1 (1999): 67–103.

Compares the dynamics of two innovative regions: Silicon Valley and Route 128. The different trajectories of both regions is explained, building on path-dependent and dominant design explanations of change. The authors make an analytical separation between the economy of the existing firms and a separate economy of institutions that evolved to nurture new firm formation.

Lundvall, Bengt-Åke. "National Innovation Systems—Analytical Concept and Development Tool." *Industry and Innovation* 14.1 (2007): 95–119.

This paper provides an overview of the development and policy adoption of the concept of national systems of innovation over the last two decades since its inception. The author argues that to understand systems of innovation, one needs to combine organisation theory with concepts that aid in understanding the wider settings in which (inter)organisational learning takes shape.

Saxenian, AnnaLee. "The Origins and Dynamics of Production Networks in Silicon Valley." In *Understanding Silicon Valley: The Anatomy of an Entrepreneurial Region*. Edited by Martin Kenney, 141–162. Stanford, CA: Stanford University Press, 2000.

Analyzes the origins and dynamics of production networks between ICT firms in Silicon Valley. The case illustrates how interfirm networks contribute to the sustained economic and technological dynamism of that region.

Storper, Michael. *The Regional World: Territorial Development in a Global Economy*. New York: The Guilford Press, 1997.

A rich and comprehensive book about regional economic development and innovation, it offers a variety of theoretical and conceptual perspectives. Chapter 5 explores the link between systems of production, innovation and territories, framing innovation as collective action; chapter 6 elaborates case studies of innovative regions from Italy, France and the United States.

Agglomeration Economies

The literature on agglomeration economies studies the economies and diseconomies of agglomerations. A widely accepted claim is that agglomeration adds to prosperity and productivity. In the United States, workers in metro areas with big cities earn 30 percent more than workers who are not in a metropolitan area (for more empirical evidence see Glaeser 2011), and a substantial part of that difference can be ascribed to higher levels of innovation. There is a large literature on economic mechanisms that link agglomeration to innovation. Implicitly and sometimes explicitly, this literature adopts a systemic view on innovation processes and analyses the mesoeconomics of innovation in spatial contexts. Being in a larger agglomeration allows firms to share resources, to improve the match between inputs and outputs, and to learn from each other, as Duranton and Puga 2003 and Rosenthal and Strange 2004 demonstrate. Innovators benefit from the dense supplier networks found here; labor markets are thicker (leading to better matches between supply and demand); and there is more scope for job mobility between firms (Saxenian 1994). Fallick, et al. 2006 sees thick labor markets as important vehicles for knowledge transfer.

Duranton, Gilles, and Diego Puga. "Micro-Foundations Of Urban Agglomeration Economies" In *Handbook of Regional and Urban Economics*. Vol. 4, *Cities and Geography*. 1st ed. Edited by J. Vernon Henderson and Jacques-François Thisse, 2063–2117. New York: Elsevier, 2003.

Argues how local scale allows firms to share resources, to improve the match between inputs and outputs and to learn from each other. On each of these scores, innovation is particularly advantaged, relative to other activities, by agglomeration.

Fallick, Bruce, Charles A. Fleischman, and James B. Rebitzer. "Job-Hopping in Silicon Valley: Some Evidence Concerning the Microfoundations of a High-Technology Cluster." *Review of Economics and Statistics* 88.3 (2006): 472–481.

Finds higher rates of job-hopping for college-educated men in Silicon Valley's computer industry than in computer Clusters located out of the state.

Glaeser, Edward. *Triumph of the City: How Urban Spaces Make Us Human*. New York: Macmillan, 2011.

Explains the mechanisms behind the global (re)urbanization tendency, stressing the advantages of density for innovation and prosperity

Rosenthal, Stuart S., and William C. Strange. "Evidence on the Nature and Sources of Agglomeration Economies." *Handbook of Regional and Urban Economics* 4 (January 2004): 2119–2171.

Summarizes the empirical literature on the nature and sources of urban increasing returns known as agglomeration economies.

Saxenian, AnnaLee. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press, 1994.

Shows how labor mobility helps to spread new ideas and practices in regions, contributing to innovation.

Innovation at the Subregional Level: Districts, Neighborhoods, Campuses, Science Parks

The city or the metropolitan region is not the only meaningful scale at which innovative and entrepreneurial dynamics occur. The seminal contributions of both Jacobs 1969 (cited under General Overviews) and Marshall 1961 (cited under Clusters) identify the relevance of the district or neighborhood level for learning, knowledge transfer and other externalities. Rosenthal and Strange 2004 shows that human capital spillovers tend to decay after just five miles. Experimental research, like Olson and Olson 2003, hints that coinnovation is more fruitful when participants are within thirty-two yards of one another. In recent decades, many cities and regions have developed “knowledge locations”: planned, area-based initiatives aimed at agglomerating knowledge-based activities in designated city districts. The best known and most proliferated manifestation of such locations are science parks. Since the 1970s, science parks have been developed in many regions, starting in Europe and the United States in the 1970s but since proliferated in the entire world. Typically, science parks host a mix of scientific institutes, high-tech firms, and incubators, forming spatial concentrations of innovative activity. They are created to valorize or commercialize scientific knowledge, or broader to harness scientific knowledge to boost the regional knowledge-based economy. The classic work on science parks is Castells and Hall 1994 (cited under Systems of Innovation), in which the authors describe the development of various types of high-technology spaces in various regions. There is a large literature analyzing science parks from a variety of perspectives. Link and Scott 2003 discusses the development of US science parks, and how it affects the academic mission of the universities. Zhou 2005 provides a Chinese perspective, describing the development of the Zhongguancun Science Park in Beijing. In an update of Castells and Hall, Miao, et al. 2015 identifies governance and synergy building among science park partners as key factors in the development of science parks and similar types of knowledge complexes. Katz and Wagner 2014 reviews a range of literature that documents the rise of urban knowledge locations—urban campuses, innovation districts, creative quarters—that represent a new geography of innovation. There are empirical indications, for instance in Florida and Mellander 2016, of a shift in venture capital investment, startup activity, and high-tech development to urban centers and to mixed-use, walkable, and transit-oriented areas. That does not mean that all innovation will end up in urban cores, as van Winden and Carvalho 2016 argues; while urban settings add value in creative industries, more suburban or periurban locations (e.g., science and technology parks) continue to be attractive for activities where innovation is more planned and formalized, does not rely on incidental or “serendipitous” contacts, and where many networks are regional and (inter)national rather than hyperlocal.

Florida, Richard, and Charlotta Mellander. “Rise of the Startup City: The Changing Geography of the Venture Capital Financed Innovation.” *California Management Review* 59.1 (2016): 14–38.

Posits that the suburban development model might have been an historical aberration; innovation, creativity, and entrepreneurship are realigning in the same urban centers that traditionally fostered them.

Katz, Bruce, and Julie Wagner. *The Rise of Innovation Districts: A New Geography of Innovation in America Metropolitan Policy Program*. Washington: Brookings Institution, 2014.

Introduces the notion of innovation districts as geographic areas where leading-edge anchor institutions and companies cluster and connect with startups, business incubators, and accelerators.

Link, Albert N., and John T. Scott. “U.S. Science Parks: The Diffusion of an Innovation and Its Effects on the Academic Missions of Universities.” *International Journal of Industrial Organization* 21.9 (2003): 1323–1356.

History of the diffusion of the science park concept since the 1980s. Analyzes their growth and also their reported impact on the missions of their host universities. It suggests that academic curricula become more applied when a science park is nearby.

Miao, Julie Tian, Paul Benneworth, and Nicholas A. Phelps, eds. *Making 21st Century Knowledge Complexes: Regions and Cities*. New York: Taylor and Francis, 2015.

This edited volume revisits the idea of Castells and Hall’s classic book on how technopoles are drivers of regional innovations. It contains contemporary case studies and new analytical frameworks to understand location-based innovation processes and the dynamics of various types of knowledge locations.

Olson, Gary, and Judith Olson. “Mitigating the Effects of Distance on Collaborative Intellectual Work.” *Economics of Innovation and New Technology* 12.1 (2003): 27–42.

Identifies the specific advantages of close proximity (“radical co-location”), in which participants share a common room or workspace.

Rosenthal, Stuart S., and William C. Strange. "Evidence on the Nature and Sources of Agglomeration Economies." *Handbook of Regional and Urban Economics* 4 (January 2004): 2119–2171.

Studies the attenuation of agglomeration and human capital effects. Finds that the benefits of spatial concentration are driven by proximity to college-educated workers, an instance of human capital spillovers, and that these effects attenuate sharply with distance.

van Winden, Willem, and Luis Carvalho. "Urbanize or Perish? Assessing the Urbanization of Knowledge Locations in Europe." *Journal of Urban Technology* 23.1 (2016): 53–70.

Discusses the urban turn in the development of knowledge locations, but concludes that certain types of innovation will flourish in less central urban or other connected areas.

Zhou, Yu. "The Making of an Innovative Region from a Centrally Planned Economy: Institutional Evolution in Zhongguancun Science Park in Beijing." *Environment and Planning A* 37.6 (2005): 1113–1134.

Analyzes the evolution of Zhongguancun in Beijing, China's most prominent science and technology park, in the context of changing interaction modes among the Chinese state, Chinese technology companies, and multinational firms, during three different stages of the park's development.

Clusters

The extant literature on economic clusters sheds light on systemic features of innovation in specialized sectors or economic branches localized in (urban) regions. Back in the 19th century, Marshall 1961 observed how economic activities cluster in particular places, and how localized innovation processes were fueled by both interfirm rivalry and mutual learning and knowledge exchange. Porter 2000 reintroduces the topic to a wider scientific and business audience, arguing how clustering fosters firm competitiveness. Colocated firms are found to be able to establish a local pool of skilled labor, reduce interfirm transactions costs, and generate knowledge spillovers. According to Malmberg, et al. 1996 and Brenner and Mühlig 2012, interdependencies between clustered firms provide the opportunity to learn from new insights, to respond to changes, and to generate innovations thanks to exposure to diverse practices. A more recent line of research emphasizes the role of spinoff dynamics—new firms' creation out of existing firms—as responsible for cluster formation, as Klepper 2010 discusses. A key tenet in studies on clusters and innovation is the role of proximity in innovation processes. Beyond physical and geographical proximity, Boschma 2005 identifies institutional, cognitive, and social proximity as relevant yet interrelated dimensions.

Boschma, Ron. "Proximity and Innovation: A Critical Assessment." *Regional Studies* 39.1 (2005): 61–74.

Argues that geographical proximity should not be analyzed in isolation, but rather in relation to other dimensions of proximity: cognitive, social, or organizational proximity. Proximity may also have negative impacts on innovation due to the problem of lock-in; too much proximity may be detrimental to interactive learning and innovation.

Brenner, Thomas, and André Mühlig. "Factors and Mechanisms Causing the Emergence of Local Industrial Clusters: A Summary of 159 Cases." *Regional Studies* 47.4 (2012): 480–507.

In a meta-study based on 159 cases, the authors address the question of how local industrial clusters emerge and how the causes or prerequisites for the emergence of industrial clusters differ according to time, space, and industry.

Klepper, Steven. "The Origin and Growth of Industry Clusters: The Making of Silicon Valley and Detroit." In *Special Issue: Cities and Entrepreneurship: Sponsored by the Ewing Marion Kauffman Foundation (www.kauffman.org)*. Edited by Edward L. Glaeser, Stuart S. Rosenthal, and William C. Strange. *Journal of Urban Economics* 67.1 (2010): 15–32.

Shows how new industries emerge from related industries when entrepreneurs exploit the relevant capabilities from related industries in the context of a new industry.

Malmberg, Anders, Örjan Sölvell, and Ivo Zander. "Spatial Clustering, Local Accumulation of Knowledge and Firm Competitiveness." *Geografiska Annaler: Series B, Human Geography* 78.2 (1996): 85–97.

Explains the process of local knowledge accumulation, and find barriers to the diffusion of knowledge that vary from one local milieu to another.

Marshall, Alfred. *Principles of Economics*. 9th Variorum Edition. Edited by C. W. Guillebaud. London: Macmillan, 1961.

In this highly influential work (originally published in 1890), Alfred Marshall wrote a much-cited chapter on the externalities of specialized industrial locations in England (chapter 10).

Porter, Michael E. "Location, Competition, and Economic Development: Local Clusters in a Global Economy." *Economic Development Quarterly* 14.1 (2000): 15–34.

Porter identifies clusters, defined as geographic concentrations of interconnected companies, as a relevant feature of national, regional, state, and metropolitan economies. He argues that clusters are loci for the microeconomics of competition and a source of competitive advantage in knowledge-based economies.

Triple and Quadruple Helix

The triple helix concept has had a deep and lasting impact on the academic and policy debates on innovation systems. Introduced in the early 1990s and well summarized in Ranga and Etzkowitz 2013, the concept focuses on dynamic network arrangements between the overlapping institutional spheres of industry, government, and academia. Each sphere relates to the other two, with an emerging overlay of communications, networks, and organizations among the helices. Innovations emerge in this network of relations, in a subdynamics of intentions, strategies, and projects. Favorable environments for innovation emerge at the intersections of the spheres, evoking creative synergies, new venues for interaction, and new organizational formats, where individual and organizational actors not only perform their own role, but also "take the role of the other" (Etzkowitz 2003). The relationships among the institutional spheres of university, industry, and government are continuously reshaped in "an endless transition," enhancing innovation by giving birth to new technologies, new firms, and new types of relationships. Based on the triple helix concept, Etzkowitz and Klofsten 2005 proposes that urban and regional knowledge-based development critically depends on fruitful university–industry–government interactions, highlighting the critical role of an entrepreneurial university. Follow-up studies identify the urban region as a relevant spatial dimension where this interplay takes shape. Carayannis and Campbell 2009 argues for a quadruple helix that also includes the user in the equation, based on growing number of studies that stress the role of users and citizens in innovation creation processes, as introduced in von Hippel 2005.

Carayannis, E. G., and D. F. Campbell. 'Mode 3' and 'Quadruple Helix': Toward a 21st century fractal innovation ecosystem. *International Journal of Technology Management* 46.3–4 (2009): 201–234.

Proposes a "Quadruple Helix" model, integrating the perspective of the media-based and culture-based public as fourth helix.

Etzkowitz, Henry. "Innovation in Innovation: The Triple Helix of University-Industry-Government Relations." *Social Science Information* 42.3 (2003): 293–337.

An accessible read on the increased importance of knowledge and the role of the university in the incubation of technology-based firms. The entrepreneurial university proactively puts knowledge to use and operates according to an interactive rather than a linear model of innovation.

Etzkowitz, Henry, and Magnus Klofsten. "The Innovating Region: Toward a Theory of Knowledge-Based Regional Development." *R&D Management* 35.3 (2005): 243–255.

Proposes that urban and regional knowledge-based development critically depends on fruitful university–industry–government interactions, highlighting the critical role of the entrepreneurial university.

Ranga, Marina, and Henry Etzkowitz. “Triple Helix Systems: An Analytical Framework for Innovation Policy and Practice in the Knowledge Society.” *Industry & Higher Education* 27.4 (2013):237–262.

Contains a concise summary of the triple helix concept and its development.

von Hippel, Eric. *Democratizing Innovation*. Cambridge, MA: MIT Press, 2005.

Von Hippel’s work on user-centered innovation puts the focus on users and citizens as key (and active) players in innovation processes. This insight helped to add the user or citizen as fourth helix.

Intermediation in Urban Innovation Processes

Innovation networks between actors are the central feature of urban innovation systems. Recent studies like Howells 2006 underline the important roles of intermediaries in the process of innovation and knowledge formation and sharing between innovative actors in urban areas. Innovation intermediaries (consultants, technology brokers, public sector agencies) play important roles in innovation processes in general, and in cities in particular, as Simmie and Strambach 2006 shows. Stewart and Sampsa 2008 defines intermediaries as “actors who create spaces and opportunities for appropriation and generation of emerging technical or cultural products by others who might be described as developers and users” (p. 296). Initially, intermediaries were predominantly seen as “middlemen” connecting users and suppliers of new technologies or innovations. But increasingly, with linear innovation models being replaced by more interactive ones—emphasizing uncertainty and complex interactions between multiple actors resulting in innovation, as van de Ven, et al. 1999 argues—the functions of intermediaries are recognized as interwoven in the innovation process itself, co-shaping innovations along various stages and cycles. Agogué, et al. 2017 summarizes the literature and describes several roles and activities played by intermediaries within innovation processes: the articulation of client needs and requirements; technology assessment and evaluation; arbitration and brokering; facilitating learning and collaboration in networks; managing and allocating financial and human resources; prototyping and piloting; accreditation and setting standards; investment appraisal and business planning; and training, education, and communication (see Bessant and Rush 1995 for an example of this).

Agogué, M., E. Berthet, T. Fredberg, et al. “Explicating the Role of Innovation Intermediaries in the “Unknown”: A Contingency Approach.” *Journal of Strategy and Management* 10.1 (2017): 19–39.

Provides a clear overview of the recent literature on innovation intermediaries, and stresses the role of the intermediary as active player—rather than passive broker or connector—in the innovation process.

Bessant, John, and Howard Rush. “Building Bridges for Innovation: The Role of Consultants in Technology Transfer.” *Research Policy* 24.1 (1995): 97–114.

Pays attention to the intermediary roles played by consultants within technology policy: they derive implications for government technology, transfer policies, and review examples of innovative technology transfer policies.

Howells, Jeremy. “Intermediation and the Role of Intermediaries in Innovation.” *Research Policy* 35.5 (2006): 715–728.

Seminal paper investigating the issue of intermediation and the role of intermediaries in the innovation process.

Simmie, James, and Simone Strambach. “The Contribution of KIBS to Innovation in Cities: An Evolutionary and Institutional Perspective.” *Journal of Knowledge Management* 10.5 (2006): 26–40.

Develops an evolutionary and institutional approach to understanding the role of certain specialist services in innovation and illustrates how significant they are for the economies of large metropolitan areas in England and Germany. Edited by Francisco Javier Carrillo.

Stewart, James, and Hyysalo Sampsa. “Intermediaries, Users and Social Learning in Technological Innovation.” *International Journal of Innovation Management* 12.3 (2008): 295–325.

Explores the role of intermediaries in the development and appropriation of new technologies. Focuses on intermediaries that facilitate user innovation.

van de Ven, A. H., D. E. Polley, R. Garud, and S. Venkataraman. *The Innovation Journey*. New York: Oxford University Press, 1999.

Describes the innovation process as a nonlinear dynamics system. The “innovation journey” involves motivating and coordinating people to develop and implement ideas. It requires an engagement in transactions with others while making the adaptations needed to achieve desired outcomes within changing organizational contexts.

Public Procurement of Innovation

The literature on public procurement of innovation (PPI) (e.g., Obwegeser and Dueholm Müller 2018) deals with the question of how government procurement can be harnessed to generate innovations. In its simplest formulation, PPI consists in using public budgets and government’s demand to enact and diffuse innovations in society. PPI can be an effective lever to promote innovation-driven economic development according to Edler and Georghiou 2007, and also to tackle societal challenges related to climate change and several other urbanization-related issues, as Coenen, et al. 2015 highlights. According to OECD 2015, local and regional government procurement accounts for about 30 percent of all public procurement in OECD countries (rising to 47 percent in Sweden and 62 percent and 68 percent in Denmark and Canada, respectively). Cities are increasingly understood as locales where innovation challenges emerge and where new knowledge is co-created to address grand challenges such as aging, climate change, and energy transition. Uyerra, et al. 2017 frames cities as central sites where rich and fluid conversations between clients and local innovative firms occur—a key precondition for successful PPI.

Coenen, Lars, Teis Hansen, and Josephine V. Rekers. “Innovation Policy for Grand Challenges. An Economic Geography Perspective.” *Geography Compass* 9.9 (2015): 483–496.

Addresses the question of how insights on economic geography can improve researchers’ and policymakers’ understanding of the potential for innovation policies to address grand challenges.

Edler, Jakob, and Luke Georghiou. “Public Procurement and Innovation—Resurrecting the Demand Side.” *Research Policy* 36.7 (2007): 949–963.

Discusses the scope for public procurement to be an element of a demand-oriented innovation policy.

Obwegeser, Nikolaus, and Sune Dueholm Müller. “Innovation and Public Procurement: Terminology, Concepts, and Applications.” *Technovation* 74–75 (2018): 1–17.

A good starting point to explore the literature, providing a review of the literature on innovation in public procurement. The authors categorize publications based on innovation drivers, concepts, and research approaches.

OECD. 2015. *Government at a Glance 2015*. Paris: OECD, 2015.

Provides facts, figures, and data on local and regional public procurement in various OECD countries.

Uyerra, Elvira, Kieron Flanagan, Edurne Magro, and Jon Mikel Zabala-Iturriagagoitia. “Anchoring the Innovation Impacts of Public Procurement to Place: The Role of Conversations.” *Environment and Planning C: Politics and Space* 35.5 (2017): 828–

848.

Explores different forms of spatial anchoring of procurement presenting challenges and opportunities for regions. Also describes illustrative examples, and derives recommendations for place-based 'innovation-friendly' procurement.

Transitions

The transitions literature takes a systemic perspective on longer-term change processes. Innovation is seen as part of a systemic transition process, as in Geels and Schot 2007. Smith, et al. 2005 describes technological transitions as larger-scale systemic innovations (for example in energy, mobility or communications) that unfold through nonlinear coevolutionary processes between technological, social, political, and economic domains, and take place over longer periods of time. An existing more or less stable system or "regime" (defined as interacting artefacts, technologies, infrastructures, every day practices, policies, values, and institutions) can be challenged by new innovations that are incubated in "niches," defined as protected experimental settings where new technologies and innovations are tested by new constellations of actors, with the ambition to present alternatives to the current regime. The literature on strategic niche management discusses how to co-construct such niches appropriately as building blocks for broader societal changes toward sustainable development (see Schot and Geels 2008 for an overview on the literature on strategic niche management). In recent years, the role of geography in transitions has gained more attention; regions and cities have become recognized as important contexts in which transitions take shape, or even as drivers of transitions. Cities are identified as relevant niche arenas where concrete experiments and innovations are developed and fostered. From various angles, Carvalho 2015, Rohracher and Späth 2014, and Hodson and Marvin 2010 elaborate on the role of cities, suggesting that cities, under big pressure, are actively shaping sustainability transitions. For a number of these cities, the authors provide evidence of expectations, aspirations and plans to undertake purposive sociotechnical transitions. Joss 2015 takes a policy perspective, and outlines how innovations and new ideas about urban sustainability materialize.

Carvalho, Luís. "Smart Cities from Scratch? A Socio-Technical Perspective." *Cambridge Journal of Regions, Economy and Society* 8.1 (2015): 43–60.

Analyzes how two paradigmatic smart city initiatives develop, and unravels the tensions and bottlenecks involved in nurturing socially rich innovation ecosystems and in maintaining social and political support over time.

Geels, Frank W., and Johan Schot. "Typology of Sociotechnical Transition Pathways." *Research Policy* 36.3 (2007): 399–417.

Uses historical examples to develop a typology of four transition pathways: transformation, reconfiguration, technological substitution, and dealignment and realignment.

Hodson, Mike, and Simon Marvin. "Can Cities Shape Socio-Technical Transitions and How Would We Know If They Were?" *Research Policy* 39.4 (2010): 477–485.

Stresses the active role of cities as innovation arenas. Presents evidence that large world cities have explicit political aspirations to change the sociotechnical organization of infrastructure networks.

Joss, Simon. *Sustainable Cities: Governing for Urban Innovation*. New York: Macmillan International Higher Education, 2015.

Considers the development of urban sustainability transitions as processes of innovation and governance. It focuses on how innovations and new ideas about urban sustainability materialize; how they enter policy debates and are translated into strategies, actions and plans; and how they conflict or co-evolve with vested interests and policy routines.

Rohracher, Harald, and Philipp Späth. "The Interplay of Urban Energy Policy and Socio-Technical Transitions: The Eco-Cities of Graz and Freiburg in Retrospect." *Urban Studies* 51.7 (2014): 1415–1431.

Describes the cities of Graz in Austria and Freiburg in Germany as ecological model cities. Both cities actively fostered transitions toward more sustainable and low-carbon energy systems.

Schot, J., and F. W. Geels. “Strategic Niche Management and Sustainable Innovation Journeys: Theory, Findings, Research Agenda, and Policy.” *Technology Analysis & Strategic Management* 20.5 (2008): 537–554.

Overview article on strategic niche management. The authors make a distinction between niche internal processes (learning, networking, visioning, and the relationship between local projects and global rule sets that guide actor behavior) and external ones that interfere with the regime of landscape levels.

Smith, Adrian, Andy Stirling, and Frans Berkhout. “The Governance of Sustainable Socio-Technical Transitions.” *Research Policy* 34.10 (2005): 1491–1510.

Offers insights on different contexts and conditions for regime transformation, as well as the role of agency.

Smart Cities

The ambiguous concept of “Smart Cities” is associated with the interplay of urban development and new technologies—mainly ICTs and a range of green technologies; Mora, et al. 2017 reviews the literature. The smart city literature discusses, from a wide variety of angles, urban innovations in the fields of mobility, clean energy, climate mitigation, and the application of information technologies in security and public spaces. Zanella, et al. 2014 notes that two “smart city” models can be broadly discerned; the first is the corporate “solutionist” model, endorsed by large multinational IT tech firms, which presents new technology as solution for a variety of urban problems. Innovation is driven by the desire to exploit this new and promising market. This model is criticized for failing to address complex social, cultural, and political aspects of new urban technologies and their adoption, as argued in the influential book Townsend 2013. A second model takes a humancentric perspective of ICT-driven urban innovation and development and addresses the complex interplay of technology with social, cultural, environmental, economic, and political processes, as in Hollands 2015. There is a strong interconnection with literature on Transitions and innovation systems; see Bulkeley, et al. 2014 or Carvalho 2015 for two different perspectives. Caragliu, et al. 2011 provides an EU-wide comparison of smart cities.

Bulkeley, Harriet, Vanesa Castán Broto, and Anne Maassen. “Low-Carbon Transitions and the Reconfiguration of Urban Infrastructure.” *Urban Studies* 51.7 (2014): 1471–1486.

Taking the case of urban energy networks in London, the authors analyze the role of experiments as arenas for new actor configurations but also new conflicts.

Caragliu, Andrea, Chiara Del Bo, and Peter Nijkamp. “Smart Cities in Europe.” *Journal of Urban Technology* 18. 2 (2011): 65–82.

This article discusses the often elusive definition of the concept of the “smart city” and provides a focused and operational definition—based on that it presents a comparative perspective on the geography of smart cities in the EU27.

Carvalho, Luís. “Smart Cities from Scratch? A Socio-Technical Perspective.” *Cambridge Journal of Regions, Economy and Society* 8.1 (2015): 43–60.

Studies smart cities from a Transitions perspective. Two pilot projects are analyzed as localized arenas for socio-technical experimentation and global niche formation.

Hollands, Robert G. “Critical Interventions into the Corporate Smart City.” *Cambridge Journal of Regions, Economy and Society* 8.1 (2015): 61–77.

Criticizes the dominance of the corporate smart city model. As an alternative, it considers smartness as emanating from small-scale, participatory, and citizen-based types of smart initiatives.

Mora, Luca, Roberto Bolici, and Mark Deakin. "The First Two Decades of Smart-City Research: A Bibliometric Analysis." *Journal of Urban Technology* 24.1 (2017): 3–27.

A bibliometric analysis on the first two decades of research on smart cities, published between 1992 and 2012.

Townsend, A. M. *Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia*. New York: WW Norton & Company, 2013.

Takes a critical perspective on smart city solutionism. The author catalogues the infiltration of big data and technology into the fabric of our cities, noting its benefits and potentials but also its faults and risks.

Zanella, Andrea, Nicola Bui, Angelo Castellani, Lorenzo Vangelista, and Michele Zorzi. "Internet of Things for Smart Cities." *IEEE Internet of Things Journal* 1.1 (2014): 22–32.

Discusses the adoption of Internet of Things (IoT) technology in cities. The authors argue that technology should be designed to support services delivery for citizens.

[back to top](#)

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