Fostering Innovation Clusters: The Growing Role of State Policies

Charles W. Wessner, PhD
National Academy of Sciences
Washington DC

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Executive Summary

Faced with the challenges of fostering regional growth and employment in an increasingly competitive global economy, many U.S. states and regions have developed programs to attract and grow companies as well as draw the talent and resources necessary to develop innovation clusters. These state and regionally based initiatives have a broad range of goals and increasingly include significant resources, often with a sector focus and often in partnership with foundations, universities and the private sector. Increasingly, they seek to leverage complementary federal programs to support the development of regional centers of innovation, entrepreneurship, and high-technology development.

These developments mark a significant change in paradigm in the United States where, for much of the Twentieth Century, states pursued technology-based development primarily by seeking to recruit companies from other states by offering a more competitive business and regulatory environment, lower taxes, supportive government policies, and financial and infrastructure incentives. This paper describes this evolution and illustrates this change with the contrasting approaches being taken in Ohio and New York to grow innovation clusters.

The Global Innovation Imperative

Over the past thirty years, a global consensus has formed on the importance of innovation as the principal way to address the challenges of economic development, public health, national security, and protection of the environment. Many of the world's leading countries are making unprecedented investments in promoting innovation through increased funding for research and development and through sustained support for universities and innovative small and large businesses. They are also implementing new programs and public-private partnerships to encourage the commercialization of new ideas in the marketplace.[1]

Innovation clusters— localized groups of companies developing creative products and services within an active web of collaboration that includes specialized suppliers and service providers, universities, and research institutes and organizations— are now widely associated with higher levels of economic growth and competitiveness.[2] Based on this recognition, there is an increasing global competition for the investment, knowledge, skills and resources associated with innovation clusters.[3]

With this growing competition, often backed by comprehensive government industrial policies, states confront stark economic challenges in the global era. In many cases, the nation's states and regions

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[1] For a comparative review of the challenges and opportunities faced by the United States in the face of global competition for the next generation of innovation, see National Research Council, *Rising to the Challenge: US Innovation Policy for the Global Economy*, C. Wessner and A. Wolff, eds., Washington DC: National Academies Press, 2012.

[2] Nelson Richard R. and Nathan Rosenberg. "Technical Innovation and National Systems" in Nelson, Richard R. (Ed.) *National Innovation Systems: A Comparative Analysis*. Oxford: Oxford University Press, 1993; Porter, Michael. 1998. "Clusters and the New Economics of Competition," *Harvard Business Review*. For more discussion, see Chapter 2.

[3] Waits, Mary Jo. 2000. "The Added Value of the Industry Cluster Approach to Economic Analysis, Strategy Development and Service Delivery," *Economic Development Quarterly*, Vol. 14 No. 1, February 2000 35-50. See also Muro, Mark and Bruce Katz. 2010. *The New 'Cluster Moment': How Regional Innovation Clusters Can Foster the Next Economy*. Washington DC: The Brookings Institution. September. P. 20.

have witnessed an erosion of traditional manufacturing sectors, the wholesale movement offshore of industrial chains, rising unemployment and, ultimately, declining population.[4]

A Shift in State Strategy

Recognizing these realities, traditional efforts at industrial revival using traditional policy tools, including industrial recruitment and financial incentives to industry are now being complemented by more technology-based indigenous growth strategies.[5] For much of the Twentieth Century states pursued economic development by seeking to recruit companies from other states by offering a more competitive business and regulatory environment, lower taxes, supportive government policies, and financial and infrastructure incentives.[6]

This strategy is changing. While states have traditionally seen their primary competitors as other states,[7] they are increasingly shifting their focus from intramural rivalries to competition with other regions of the world for leadership in the industries of the future.[8] States are fostering the development of local innovation clusters through long-term investments in human capital, scientific infrastructure, and knowledge-based entrepreneurship. They are seeking to leverage private and federal investments in research and infrastructure, in some cases with dramatic success.

For example, the State of New York's investment of some $1.2 billion in Albany's emerging nanotechnology cluster has drawn an estimated $13 billion in private nanotechnology investments into the region as of 2012.[9] States are engaged in sectoral industrial promotion policies in promising emerging technologies – Michigan in electric energy storage, Arkansas in wind energy, Kansas in biotechnology, Ohio in flexible electronics, additive manufacturing, and biomedicine. They are building research parks, research institutes with common infrastructure within universities, and incubators. Interestingly, a number of states have undertaken studies of best practices in other states and foreign countries.[10]

The Evolution of Federal Support

The federal role in state and regional economic development is also changing. Traditionally the federal government influenced regional development through regulatory and legal policies that defined the economic environment with respect to intellectual property, the rules of competition, taxation

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[4] For a review of current state innovation strategies, see National Research Council, *Best Practices in State and Regional Innovation Initiatives,* C. Wessner, ed., Washington DC: National Academies Press, 2013.

[5] For a recent review of state and regional policies on innovation-led growth, see David B. Audretsch and Mary L. Walshok, eds., *Creating Competitiveness, Entrepreneurship and Innovation Policies for Growth*, Northampton MA: Edward Elgar, 2013.

[6] Plosila, Walter H. 2004. "State Science and Technology-Based Economic Development Policy: History, Trends and Developments and Future Directions", *Economic Development Quarterly.* Vol. 18. No. 2. P. 114. For more discussion on the role of economic development incentives, see Chapter 4 of this report.

[7] Reed, Lawrence W. 1996. "Time to End the Economic War Between the States," *Regulation* No. 2.

[8] National Research Council, *Best Practices in State and Regional Innovation Initiatives: Competing in the 21st Century,* C. Wessner, ed., Washington DC: National Academies Press, 2013.

[9] Albany *The Times Union.* 2012 "Nanotech Makes U.S. Job Creation Special." September 19.

[10] Theresa McLendon, *Building a Knowledge-Based Economy in Arkansas: Strategic Recommendations by Accelerate Arkansas*, 2007.

levels and international trade. The federal government spent heavily on research, primarily by universities, often in a fragmented and uncoordinated manner. [11] Federal programs associated with regional economic development were a confused jumble of roughly 200 largely disconnected initiatives.[12] A few key sectors related to agriculture, energy, national security and public health benefitted from very substantial federal support for research that enhanced their position in international competition, but in most manufacturing and services sectors, the federal government was reluctant to make comparable investments. Procurement by the federal government provided critical early stage demand for some new industries, enabling them to achieve economies of scale and to enter commercial production, but these were exceptions largely limited to defense-related or dual use technologies.[13]

In many cases, states and regions promoted innovation clusters without concerted federal support in the years after the mid-1990s. Since 2009, however, the federal government has begun to augment state programs with its own explicit cluster-promoting initiatives. These initiatives include "energy-innovation hubs," established under the auspices of the Department of Energy; financial support for cluster development by the Economic Development Administration and the Small Business Administration; and a newly launched National Network for Manufacturing Innovation (NNMI), a multi-agency collaboration to establish regional hubs of manufacturing excellence engaging universities, companies, and government.[14]

The Role of the States

State leadership in innovation enjoys a rationale that extends beyond the parochial concerns of local leaders. While federal spending on R&D is massive, the greatest proportion of this expenditure is devoted to defense and national-security-related technology development projects sponsored by the Departments of Defense, Energy, and Homeland Security.[15] While much of the defense related research spending benefits private companies conducting contract R&D, the research results frequently cannot be applied in the commercial realm and indeed, federal policy priorities often divert funds and the efforts of private contractors away from consumer and industrial markets.[16] Accordingly, "state governments justify their involvement as brokers and patrons of the technology-transfer process on the grounds that their priorities lie in the development of innovations to be sold in the open market, transactions that will ultimately enhance the local economy."[17]

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[11] National Research Council, *Research Universities and the Future of America: Ten Breakthrough Actions Vital to Our Nation's Prosperity and Security,* Washington DC: National Academies Press, 2012.

[12] Otis Graham Jr, *Losing Time: The Industrial Policy Debate,* Cambridge Ma: Harvard University Press 1992.

[13] David C. Mowery, Chapter 29 – Military R&D and Innovation," in *Handbook of the Economics of Innovation* Volume 2, Elsevir, 2010, Pages 1219–1256.

[14] See NSTC, "National Network for Manufacturing Innovation: A Preliminary Design." Washington DC: The White House, January 2013.

[15] For a review of the division of federal R&D spending, see AAAS Report XXXVII, Research and Development, FY 2013

[16] For a classic review of the potential and limitations of military R&D, see John Alic et al., *Beyond Spinoff*, Boston: HBS Press, 1992.

[17] Eisinger. *Rise of the Entrepreneurial State*. Op. Cit. p. 275.

Indeed, a number of academic studies have concluded that in the development of technology pioneering firms, state support has played a key role in pooling multiple external public and private funding sources, including federal funds and venture capital, and directing them to private firms.[18] As one U.S. Department of Commerce official commented with respect to the federal role in economic development, "state and local leaders tend to be ahead of the curve." Regional innovation clusters cannot be legislated from above—"they are organic. You have to have champions at the local, private sector and state levels. What we can do is work with those folks as true partners and customize the deployment of federal resources to amplify and accelerate that particular cluster."[19]

American states and municipalities can often use policy levers with greater precision and effectiveness than the federal government. They control factors of production such as land use and availability, infrastructure, power and water, and waste disposal. Every state supports a system of public universities, institutions that, along with their private counterparts, have been at the forefront of innovation-driven economic development for well over a century. While federal government research grants and contracts influence the activities of the public and private universities, the largest substantial proportion of the operating budgets (non-targeted funds) of public universities are still derived from state governments, which remain in a position to encourage educational institutions to align their priorities with local economic development.[20] The states likewise control the provision of public K-12 education, which depending on its quality, can foster the development of an adult work force with the skill levels necessary to support an innovation-driven economy.

Using Universities as Economic Drivers

Many states are seeking to capitalize on their investments in public research universities to drive local economic growth and firm creation. Engineering and applied science are incorporated in the curricula of most U.S. research universities, which reinforces "the long-standing predisposition of U.S. universities toward problem-solving, working with industry, and training people for industry."[21] According to Robert Berdahl, "Research universities also provide the scientific, technical, and professional foundations for those who will go on to found and lead the new industries made possible by innovative research."[22]

Indeed, successful state and regional innovation ecosystems in the United States are often driven by research universities. Underlying the success of innovation clusters such as Silicon Valley, Boston's Route 128, and the Research Triangle of North Carolina are local universities with a longstanding mission of spurring economic development by developing technology with and transferring technology to local industry and stimulating the creation of new businesses in university-centered incubators and science parks. These and other innovation ecosystems are dominated by triadic collaborations involving

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[18] Fernandez-Ribas, Andrea. Public Support to Private Innovation in Multi-Level Governance Systems: An Empirical Investigation. *Science and Public Policy*. July 2009. P. 459.

[19] Comments of U.S. Assistant Secretary of Commerce for Economic Development John Fernandez in National Research Council, *Clustering for 21st Century Prosperity: Summary of a Symposium,* C. Wessner, Rapporteur, Washington DC: National Academies Press, 2012.

[20] NSF, Science and Engineering Indicators 2012, Chapter 6.

[21] Ibid. P. 323.

[22] Robert Berdhal, "Research Universities: Their Value to Society Extends Well Beyond Research," April 2009

universities, industry, and government, with institutional arrangements that promote silo-breaking and multidisciplinary research. Technology-intensive companies commonly locate their operations near the best universities in particular fields of science and engineering in order to enable their internal research departments to work with "star" scientists and to recruit promising students.[23]

A growing number of states are drawing on their public universities and other research and educational organizations to serve as engines of sustainable, innovation-led growth. For example, the University of Hawaii under the leadership of its President, Dr. M.R.C. Greenwood, has recently sought to identify research as an industry in Hawaii, undertake a strong recruiting effort to attract the top academics in areas which the University of Hawaii has a strategic advantage, such as volcanology, astronomy and oceanography; and formalize relationships to encourage collaborations similar to consortia. Based on the advice of a panel of experts, the University has also established the Hawaii Innovation Technology Exchange Institute, which is staffed with technology transfer professionals, to promote public/private collaboration on translational research and offer assistance to start-ups from proof-of-concept centers and innovation centers.[24] The aim is to leverage the capabilities and research strengths of the university to develop distinctive innovation clusters that diversity the state's economy and foster economic development.

The Focus on Innovation Clusters

The states have been the primary movers in the widespread and growing practice of fostering innovation clusters as an economic development tool. In his seminal 1990 book *The Competitive Advantage of Nations,* Michael Porter argued that in advanced economies, regional "clusters" of related industries—not individual companies or sectors—are the primary source of competitiveness, export growth and rising employment and income levels.[25] Clusters can be defined, in static terms, as geographically localized concentrations of firms in related sectors that do business with each other and have common needs for trained workers, infrastructure and technology.

Professor Maryann Feldman has observed that cluster formation "is a process predicated on the actions of entrepreneurs and their symbiotic relationships with their local environments. In this more dynamic understanding, the cluster and its characteristics emerge over time from the individual activities of the entrepreneurs and the organizations and institutions that evolve to support them."[26] This perspective

[23] Illustrating the impact a single research university can have on a region, in 2004 alone MIT produced 133 patents, launched 20 startup companies, and spent $1.2 billion in sponsored research. Data from 1994 shows that, at that time, MIT graduates had founded over 4,000 companies employing 1.1 million people generating $232 billion in sales worldwide. See Presentation of David Daniel, University of Texas at Dallas, "Making the State bigger: Current Texas University Initiatives," National Research Council, *Clustering for 21st Century Prosperity: Summary of a Symposium,* Washington DC: National Academies Press, 2011. This figure models MIT graduates who went on to other institutions for graduate studies and who founded companies in clusters distant from MIT itself.

[24] National Research Council, *Building Hawaii's Innovation Economy*, Washington DC: National Academies Press, 2012.

[25] See Also Michael Porter, "Clusters and the New Economics of Competition", *Harvard Business Review.* 1998. Although the cluster concept predates Porter by nearly a century, and the cluster phenomenon itself is as old as history, Porter popularized it so effectively that since his book appeared the cluster concept has come to dominate the economic development thinking in advanced countries, including the United States.

[26] Feldman, Maryann and Johanna Francis, "Homegrown Solutions: fostering Cluster Formation", *Economic Development Quarterly,* May 2004.

implies that because clusters are rooted in the language and culture of a particular time and place, "replicating a successful cluster model elsewhere can be highly elusive."[27]

At present, most state and regional development efforts in technology-intensive industries are based on cluster formation.[28] A 2010 report by the Brookings Institution observed that "with little or no past federal support, numerous U.S. regions and states today operate several hundred distinct cluster initiatives—formally organized efforts to facilitate cluster growth."[29] Clusters attract the attention of state, regional, and local policymakers "because of the economic vibrancy that a successful cluster can give an area."[30] NorTech, a highly regarded non-profit technology-oriented development organization serving Northeast Ohio, recently summarized the local benefit clusters can deliver: "(1) transition from unemployment to high-skill employment; (2) create new higher-wage job opportunities; (3) develop local businesses less susceptible to offshoring; (4) stabilize communities by re-purposing idle assets and people; and (5) manufacture products in the region for export, restoring value to the region."[31]

The remainder of this paper highlights two distinctive state-based approaches to develop high-technology clusters. The approach centered in northeast Ohio is based on growing linkages among private industry and universities, facilitated by a variety of intermediating institutions and supported by the state's Third Frontier program, to develop high-technology clusters in flexible electronics, additive manufacturing, and bio-medicine. By contrast, New York's approach has focused primarily on developing a state-of-the-art research infrastructure for nano technology research at SUNY at Albany. This in turn has attracted leading makers of semiconductor devices, equipment, and service infrastructural companies to the Albany NY area.

Growing Innovation Clusters in Northeast Ohio

In the second half of the Twentieth Century, Ohio experienced a dramatic economic decline as traditional industries like steel, automotive, glass, and rubber were buffeted by foreign competition and in some cases began to move offshore. Average incomes in Ohio fell from 11 percent above the national average in the 1950s to 6 percent below by 2001.[32] Ohio was "mired complacently in what has been labeled the old economy, characterized by production-line manufacturing" but was lagging the nation in knowledge-based areas such as information technology, biotechnology, and business and professional services. With these declines, the region was pejoratively called the Rust Belt.

However, recent efforts in northeast Ohio to spur an industrial and economic turnaround are increasingly attracting national attention. This has been backed by strong and longstanding support from the state government. The Third Frontier program, created in 2002 and extended in 2010 through

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[27] National Research Council, *Growing Innovation Clusters for American Prosperity*, C. Wessner, Rapporteur, Washington DC: National Academies Press, 2012.

[28] Mary J Waits, "The Added Value of the Industry Cluster Approach to Economic Analysis, Strategy Development and Service Delivery", *Economic Development Quarterly*, Vol. 14 No. 1, February 2000 35-50.

[29] Mark Muro and Bruce Katz. *The New 'Cluster Moment': How Regional Innovation Clusters Can Foster the Next Economy*. Washington DC: The Brookings Institution, September 2010, P. 20.

[30] Eugene Seeley, "A New View on Management Decisions that Lead to Locating facilities in Innovation Clusters", *Journal of Business Inquiry,* Vol. 10. 2011.

[31] NorTech. "Why Clusters Matter." Access at www.nortech.org/clusters/why-clusters-matter.

"Legislators Badly Weaken State Colleges," [32] *The Columbus Dispatch, November* 25, 2001.

2015 with a budget of $2.3 billion, is designed to support early-stage research and development efforts "from which the private sector often shies away, the payoff likely too far in the future."[33] The state also funds the Thomas Edison Program, which encourage universities to cooperate with businesses to link research and technology with start-up companies and other business initiatives.

Ohio's innovation initiatives take an expansive view of the role of universities in the local economy, which work closely with industry in new ways to foster local economic development. The University of Akron, for example, has sought to play an active role in the region's innovation-based economic development by through broadening its engagement with the region's firms and research organizations. It has formed a strategic partnership with Timken, a manufacturer of steel bearing, where the company develops its own technology at a new university facility, but allows other companies to benefit from technologies relevant to markets that Timken does not compete in.[34]

The strong engagement of innovation intermediaries are a distinguishing feature of Ohio's strategy. By providing mentoring, networking, and early stage funding, as well as by creating detailed sectoral roadmaps in collaboration with local public and private actors, nonprofit organizations such as NorTech are seeking to foster the formation of innovation clusters in northeast Ohio.[35] These efforts have been complemented by the region's philanthropic organizations, through their willingness to take risks and bring substantial resources to bear on new initiatives and institutions.

A key example is the development of the FlexMatters Accelerator initiative in 2006 by NorTech and Kent State University. This effort to establish a flexible electronics industry in northeast Ohio subsequently broadened to include the University of Akron, the Center for Multifunctional Polymer Nanomaterials and Devices, and local companies.[36] FlexMatters received a $900,000 grant from the Ohio Third Frontier program in 2007 and chose a site in a new research park being established by Kent State, Centennial Research Park.[37] According to NorTech's 2010 roadmap, the ultimate goal of this effort is to create 1,500 jobs, $75 million in payroll and $100 million in capital for the northeastern Ohio.[38]

Building a Nano Cluster in New York

As with Ohio, New York has sought to reverse a long period of economic decline. In the mid-1990s, upstate New York (the region north of the New York Metropolitan Area) had "one of the weakest, if not

[33] "Initiative Seeks Top Researchers: $143 Million Goes to Universities for Cutting Edge Solutions," Cleveland, The *Plain Dealer* (May 21, 2008).

[34] "Timken, UA Launch Venture—'Open Innovation' Partnership Allows University Students to Develop New Applications of Core Technology," *Akron Beacon Journal, October* 20, 2012.

[35] Rebecca Bagley, "The Role of NorTech: Promoting Economic Development," In National Research Council, *Building the Ohio Innovation Economy: Summary of a Symposium,* C. Wessner, Washington DC: National Academies Press, 2013.

[36] "KSU Dedicates New Research Park," *Akron Beacon Journal* (June 9, 2007); "6 Projects Get NorTech Money," Cleveland *The Plain Dealer* (November 15, 2006).

[37] "KSU Dedicates New Research Park," *Akron Beacon Journal* (June 9, 2007).

[38] NorTech, FlexMatters *Strategic Roadmap: Accelerating Growth in Northeast Ohio's Flexible electronics Cluster* (November 2010); "Banking on Flexible Plastic: Nonprofit Aims to Provide Support for Promising New Industry in Northeast Ohio," *Akron Beacon Journal* (November 10, 2010).

the weakest, economies of any region in the country."[39] Economic mainstays of the region, such as Xerox, Kodak, and Bausch & Lomb, were shedding thousands of jobs, and companies and individuals were leaving to pursue opportunities in other parts of the country. Between 1995 and 1997, "departures exceeded arrivals in upstate New York by nearly 169,000 people," and population in the region declined by about half of one percent.

To address this challenge, New York's then-Governor George Pataki convened a group of stakeholders in the early 1990s, who decided that an integrated R&D, education and commercial strategy built around a Governor's Center of Excellence and anchored by a university was needed. With the encouragement of IBM, the governor's group chose "nanotechnology" as the thematic area for this effort, in recognition of the cross-cutting nature of the technology, with potential applications in many sectors. [40]

By 2004, the University of Albany had launched the College of Nanoscale Science and Engineering (CNSE) to train a specialized nanotechnology work force.[41] Faculty was drawn from other universities and from companies; in addition, CNSE brought in some scientists (including several from IBM and SEMATECH, a leading semiconductor research consortium) who worked on site but did not have teaching assignments. By 2007, CNSE had grown from an initial student body of 40 to 120 and had succeeded in recruiting preeminent scientists to its faculty. In 2006, *Small Times* magazine, a trade publication, named CNSE as the "number one college for nanotechnology."[42] In 2007, SEMATECH agreed to house the headquarters of International SEMATECH at CNSE and the college built a $100 million 250,000 square foot facility to accommodate the research consortium.[43]

The New York nanotechnology initiative is an example of state-level industrial policy on a scale comparable to that observable on a national level outside the U.S. In this case, however, the driving force was not a government agency but the SUNY university system. Through investments in SUNY at Albany, the state of New York leveraged far more substantial private financial investments, facilitating the establishment of an enormously expensive, state-of-the-art research infrastructure at the university, which then had a powerful gravitational pull on leading semiconductor devices, equipment, and service infrastructural companies. In little over a decade a semiconductor industry supply chain has been assembled in upstate New York, which is poised to lead the global industry into a new era based on 450mm wafer technology. While many actors played important roles in this effort, including government and industry leaders, regional development organizations, and private firms such as IBM and GlobalFoundries, the initial catalyst was arguably the university itself.

Conclusions

Many U.S. states and regions have awakened to the new competitive realities of the 21st Century and see the need to reinforce or create new clusters of promising technologies supported by strong

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[39] Mark M. Zandi, in "As U.S. Economy Races Along, Upstate New York is Sputtering," *New York Times* (May 11, 1997).

[40] Presentation by Pradeep Haldar, Vice President and Professor, SUNY-Albany CNSE, National Research Council symposium, New York's Nanotechnology Model: Building the Innovation Economy, Troy, NY, April 4, 2013.

[41] "U Albany to Have Nanotech College." *The Times Union*. January 8 2004.

[42] "U Albany NanoCollege Tops Rising Star at GE," *The Times Union*. February 9 2007.

[43] "SEMATECH News boon for Albany," *The Times Union,* October 17, 2007; "SEMATECH Deal Brings Business, High-Tech Jobs," *The Daily Gazette*. February 24. 2008.

universities and connected through active public private partnerships. They are developing programs to attract and grow companies as well as draw the talent and resources necessary to develop innovation clusters.

These state and regionally based initiatives have a broad range of strategies, but increasingly include significant resources, often with a sector focus and often in partnership with foundations and universities. They frequently take advantage of complementary federal programs to support the development of regional centers of innovation, entrepreneurship, and high-technology development.