Annex 2: Select State Strategies to Foster Innovation

State-based R&D Innovation Strategies

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Massachusetts and California consistently rank high in all state indexes of innovation[1]. It is clear that one of the factors driving Massachusetts's and California's leadership in innovation is that those states are home to world class research universities. This is also a factor driving North Carolina's and Georgia's recent ascension in the ranks of the various innovation ratings. Such universities attract talent, capital, and industries, resulting in a scientifically and technically skilled workforce and high patenting activity and many entrepreneurial starts ups.

Investments in Higher Education Infrastructure

How then do states without "world class" universities grow them? In the 1980s most state efforts were aimed at building research capacity through funding endowed chair or professorship positions. States also invested in the establishment of university-based centers of excellence. These programs were aimed more at strengthening research capacity but were not targeted

1 Kauffman Index of Entrepreneurial Activity: 1996-2010, March 2011; Milken Institute State Technology and Science Index 2010; and Information Technology and Innovation Foundation's (ITIF) 2010 State New Economy

towards certain technologies or research fields.[2] Moreover, government's role was restricted largely to providing funds for basic research as Figure 1 illustrates.

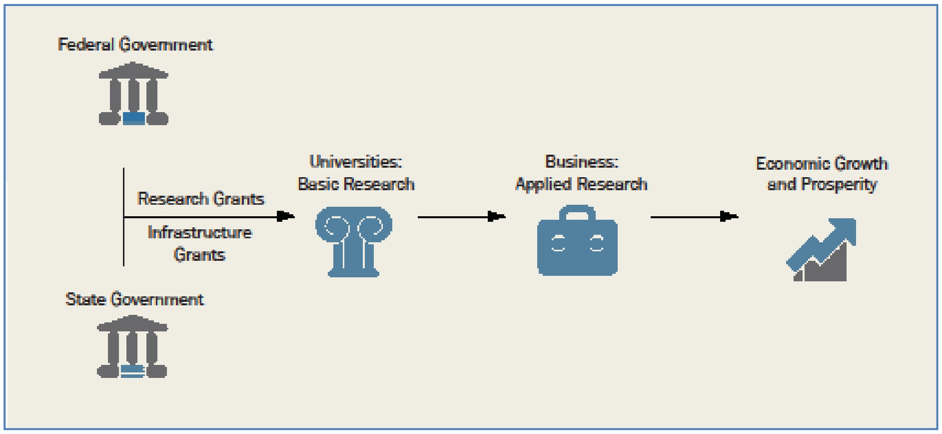

Figure 1. Traditional View of Government in the Innovation Economy

SOURCE: *Advancing Innovation in North Carolina: An Innovation Framework for Competing and Prospering in the Interconnected Global Economy*, December 2008, p. 24.

Since 1986, the state of Utah has had a Centers of Excellence Program (COE).[3] According to its 20th Anniversary Report, the program received $51.75 million in state funding and resulted in 186 patents, 226 licenses, and 126 companies were created with 55 alive in Utah, 3 alive out-of-state, and 11 acquired and out-of-state. The Utah companies employ 2,035 people with an average salary greater than $65,000. Figure 2 shows the COE's funding history from its inception in 1985 through 2007.

2 A Review of State R&D Investment Funds: Ten Case Studies: Final Report, by Heike Mayer, March 1, 2007.

3 http://business.utah.gov/site-media/page-media/content/centers/COE20thAnniversaryReportFinal8202007.pdf

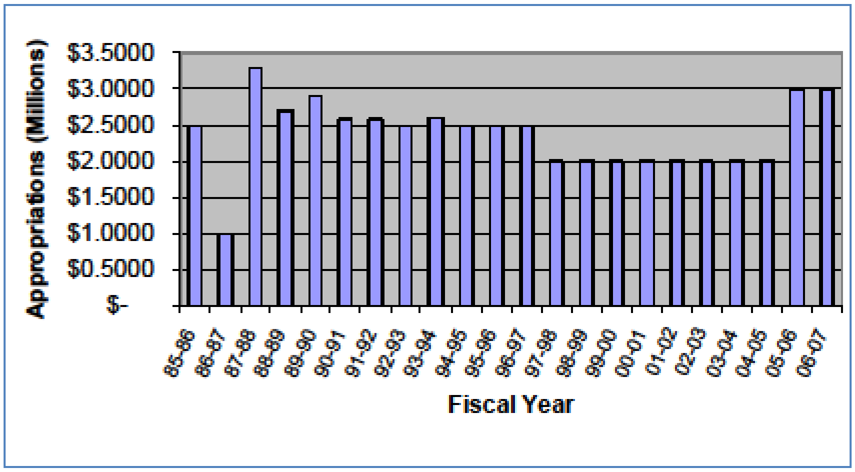

Figure 2. Utah Centers of Excellence Funding History 1985-2007

SOURCE: Governor's Office of Economic Development, *Centers of Excellence, 20th Anniversary Report (1986-2006)*, p. 6

As of March 2011, the Utah Legislature changed the name of the COE to the Technology Commercialization & Innovation Program (TCIP, reflecting the recent tendency of states to integrate their S&T programs and efforts with their economic planning, policies, and programming.[4] Studies show that successful regions have a source of basic science, such as a university or national lab, but they also have mechanisms in place that allow the region to transform and absorb the gains from research, suggesting that government has a role in entrepreneurial and commercialization support. Figure 3 is a graphic representation of this new view of government in the innovation economy.[5]

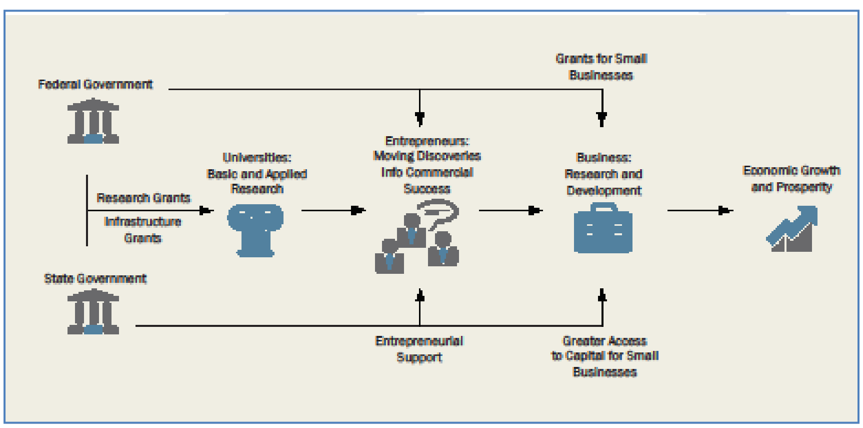

Figure 3. New View of Governmental Role in the Innovation Economy

SOURCE: *Advancing Innovation in North Carolina: An Innovation Framework for Competing and Prospering in the Interconnected Global Economy*, December 2008, p. 26

[4] State Science- and Technology-Based Economic Development Policy: History, Trends and Developments, and Future Directions, by Walter H. Plosila, Economic Development Quarterly, vol. 18, no. 2, May 2004, p. 120

[5] *Advancing Innovation in North Carolina: An Innovation Framework for Competing and Prospering in the Interconnected Global Economy*, December 2008

Since 1993, the Georgia Research Alliance (GRA) has had an Eminent Scholars Program. In 2011 GRA recruited 62 scientists to Georgia. For each scholar, GRA invests $750,000 for an endowment, an amount that the research university matches in private funds on a minimum 1-1 basis. GRA also makes investments in developing world-class research laboratories. Eminent Scholars often bring a research team, significant federal funding, and private support for their research. They advance S&T toward new discoveries and technologies – often with great commercial potential. Georgia's investment in GRA Eminent Scholars has yielded more than $1 billion in outside grants and contracts for the state and helped to launch some 35 companies. In 2007, GRA Eminent Scholars Program was the State Science and Technology Institute's (SSTI) Technology-Based Economic Development (TBED) Award Winner of the Expanding Research Category.

Ohio State University is an interesting example of an institution that is in transition from a large, relatively uninvolved (in technology-led economic development that is) land grant school to one that aspires to be Ohio's leading asset in growing a knowledge-based economy. In the FY 1999 National Science Foundation (NSF) survey of academic research and development, Ohio State reported research expenditures of $322.8 million, which ranks them 19th among all U.S. universities and 12th among public universities. As part of its"2010 objective" (to have 10 programs in the top 10, and 20 in the top 20, by the year 2010) the university believes that is has attained – or is about to reach –national stature in several areas of research and scholarship. This long-term objective is led by a small number of targeted investments in programs that have the potential to reach this goal. In the science and technology area a sample of these selective investments include: bioengineering — particularly minimally invasive surgery; cardiovascular bioengineering and medical imaging; material sciences — particularly sensors, electrical materials, and computational design of new materials; and information technology — particularly computer visualization, motion capture, and wireless technology. [6] Ohio State provides an instructive example for other state institutions with similar aspirations.

Strategically Focused State R&D Investments

Beginning in 2000, states began to strategically focus their R&D investments to construct competitive advantage by focusing on certain technology areas, leveraging federal funding and connecting universities with industry. These efforts coincided with a decrease in Federal funding and a heightened awareness among states about the competitive nature of Federal investments in R&D. [7]

6 Innovation U.: New University Roles in a Knowledge Economy, Southern Growth Policies Board, 200[2]

[7] A Review of State R&D Investment Funds: Ten Case Studies: Final Report, by Heike Mayer, March 1, 2007.

States such as North Carolina, California, and Massachusetts are increasingly referring to their "innovation ecosystems"—the complex and dynamic collection of people, organizations, policies, and programs that create innovative ideas, translate those ideas into innovative products and practices, build new companies and organizations to move those ideas forward, and nurture those new organizations to help them create jobs and (Figure 4).

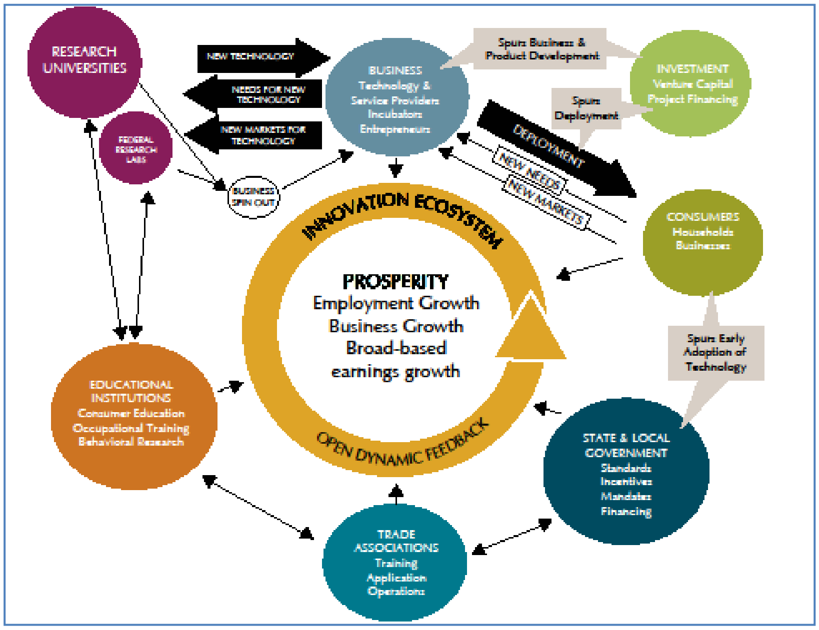

Figure 4. Assets and Dynamics of an Innovation Ecosystem

SOURCE: *Innovate 2 Innovation: An Assessment of California's Innovation Ecosystem, Phase I Report,* California Council on Science and Technology, February 2011, p. 13

The Georgia Research Alliance (GRA) VentureLab technology commercialization program was launched in 2002 and seeks out university-based research innovations, evaluates their commercial potential, and provides resources to address the management, market, and technology risks that come with new ventures. Each participating university – Georgia Tech, Emory, the University of Georgia, Georgia State University, and Georgia Health Sciences University - has an active technology incubator with which VentureLab can partner. From 2005-2010, VentureLab had evaluated the commercial potential of more than 260 university inventions or discoveries and awarded VentureLab grants to form 107 active companies. At the end of 2010, these companies employed more than 640 professionals, had attracted $460.2 million in private equity investment, and generated nearly $77 million in revenue.[8] In 2007, GRA VentureLab was the SSTI TBED Award Winner of the Commercializing Research Category.

In 2003, for the first time Massachusetts began to offer matching funds for federally funded research. The Massachusetts Research Center Matching Fund provides $30 million in matching

[8] http://www.gra.org/ProgramsInitiatives.aspx

funds to researchers interested in applying to federal programs that require university-industry partnerships. Funding is available for (1) Centers for Excellence Grants; (2) Research Center matching Grants: and (3) Research Center Development Grants.

As it has for the past several years, Massachusetts in 2008 ranked first in Small Business Innovation Research (SBIR) awards per capita, receiving $227 million in federal SBIR funds for proof-of-concept research and prototype development. It repeated this performance in 2009. Figure 5 compares Massachusetts with other leading technology states for 2009.

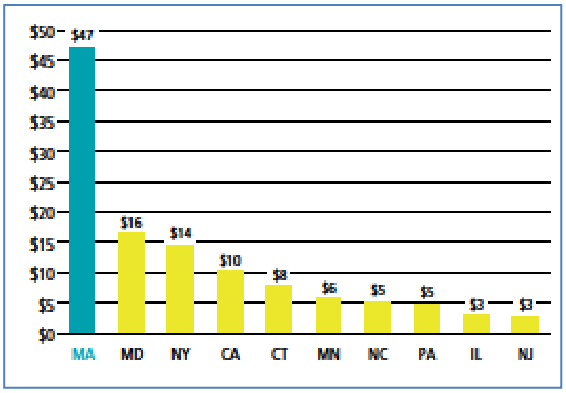

Figure 5. Dollar value of SBIR awards, per capita, Leading Technology States, 2009

SOURCE: *2010 Index of the Massachusetts Innovation Economy*, Massachusetts Technology Collaborative, p. 26

In 2004, West Virginia started the Research Challenge Fund which uses 0.5% of the state's racetrack lottery dollars to support the fund on an annual basis. As of 2007, the state had received about $4 million annually from this funding source. The state has funded six research projects at West Virginia University and Marshall University. Out of these projects five startup companies have emerged (Vandalia Research, Protea Biosciences, Datacaster Inc., Vrgris Corporation, and Progenesis Technologies). Other outcomes include more than a dozen patents, three commercial licenses, and millions of complementary dollars in the form of federal grants and venture capital.[9]

West Virginia began their Eminent Scholar Recruitment and Enhancement Program in 2009; and the WV Research Trust Fund (Bucks for Brains) in 2008. It is too early to see much in the way of results from these programs. Moreover the West Virginia legislature did not establish a Science and Research Council until 2009. The goal of this Council is to increase the capacity of the state and its colleges and universities to attract, implement and use cutting-edge, competitive research funds and infrastructure.[10]

[9] WV EPSCoR's 2006 annual report: http://www.wvepscor.org/downloads/2006 AnnualReport.pdf

[10] http://www.wvresearch.org/science-and-research-council

In 2006, Utah created Utah's Science Technology and Research initiative (USTAR) to provide funding for strategic investments at the University of Utah and Utah State University to recruit world-class researchers and build state-of-the-art research and development facilities and to form first-rate science, innovation, and commercialization teams to strengthen Utah's "knowledge economy." This initiative invests in innovation teams and research facilities at the University of Utah and Utah State University, to create novel technologies that are subsequently commercialized through new business ventures. The University of Utah and Utah State University each contribute matching funds toward the research buildings.

Another example is the University of California (UC) Discovery Grants Program, established in 1997 and administered by the Industry-University Research Cooperative Program (IURCP to promote research partnerships with industry in disciplines deemed critical to California's economic competitiveness. It is a matching grants program that promotes early-stage research in UC labs as well as accelerating research as a foundation for new products and technologies, new markets, and business expansion. UC Discovery grants are awarded in the fields of biotechnology, communications and networking, digital media, electronics manufacturing and new materials, information technology for life science as well as microelectronics. By 2006, UC Discovery Grants provided up to $60 million per year in state, industry, and university funds for new research partnerships.[11] In FY2007-2008 industry contributions comprised 58% of the total funding. However, due to state budget cuts, IUCRP decreased its contribution by just over $2.5 million between FY 06-07 and FY 07-08 which led to a resulting drop of over $4.5 million in industry contributions.[12] The UC system is also facing financial challenges as a result of the state budget deficit. For FY 2010 UC had a budget shortfall of $1 billion.[13]

Entrepreneurship Programs

One indicator of the rate of new product innovation is the number of patents issued. As technological innovation has become more important, patents issued per year have grown from 40,000 in 1985 to more than 82,000 in 2009. Moreover, the Bayh–Dole Act or Patent and Trademark Law Amendments Act which gave U.S. universities, small businesses and non-profits intellectual property control of their inventions and other intellectual property that resulted from federal government-funded research has brought about an order of magnitude increase in the number of universities actively engaged in the patenting and licensing of inventions. California ranked 4th nationally in terms of patenting growth from 1998-2009; North Carolina ranked 8th; Utah, 11th ; Georgia, 13th; and Massachusetts 14th -- with West Virginia lagging in 50th place.

[11] Innovate 2 Innovation: An Assessment of California's Innovation Ecosystem, Phase I Report, February 2011

[12] Overview of California State-Funded R&D, 2004-2007: Understanding the State's Role in Shaping R&D Spending, by M. Daniel DeCillis, California Council on Science and Technology, November 2008.

[13] California: America's Industrial R&D Powerhouse, NatureJobs, September 28, 2011 http://www.nature.com/naturejobs/science/articles/10.1038/nj0357

The next step in innovation is to transfer this technology to the private sector and commercialize it. One way to measure success in this area is number of startup firms. The University of Utah has one of the largest entrepreneurial centers in the country, the Pierre Lassonde Entrepreneur Center. Since 2000, this center has been providing real-world business experience to help entrepreneurs understand and assume the risks of business ownership and management. MIT's Deshpande Center for Technological Innovation is another example of a university technology commercialization program. Since 2002, the Deshpande Center has taken advantage of the fertile innovation environment at MIT and proved that small cash grants, and a well-defined process designed to nurture and support innovation, can accelerate the migration of ideas from the lab to practical commercial application.

In 2009, the National Association of University Technology Managers ranked University of Utah 1st in the nation for spinning off research-based companies, surpassing MIT for the first time.[14] Utah repeated this performance in 2010, outranking MIT yet again. In 2010, the University of Utah had 18 startups compared with second place MIT who had 17 new companies.[15]

In 2010, Massachusetts plunged from 15th to 38th in the number of business incubators per 10,000 business establishments according to the Milken State Technology and Science Index. This may reflect a maturing of the state's tech business sector as smaller states attempting to catch up to Massachusetts and invest more heavily in incubators.

West Virginia's TechConnectWV is a nonprofit organization of economic developers, researchers, technologists, and service providers dedicated to growing a high-technology economy in West Virginia. It was incorporated in 2006. In 2007 it released Phase I of the WV TBED Blueprint, which identified specific gaps and recommended specific technology platforms for building West Virginia's technology economy.

Access to Venture Capital

In addition to access to entrepreneurs, commercialization requires access to venture capital funding. Venture capital is a special type of equity finance for typically young, high-risk, and often high-technology firms. States vary in their abilities to access capital, particularly venture capital, for early-stage firms in high-growth sectors. On the supply side, this may be due to a lack of funds, risk-adverse attitudes, and/or the absence of an equity investment culture. On the demand side, there may not be a sufficient pool of entrepreneurs and investment-ready small firms. States need to first determine where financing gaps exist and then assess all possible

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[14] University of Utah Trumps MIT in Tech Startups, e-Week Mobile, Dec 20th 2010 by Darryl K. Taft (http://mobile.eweek.com/c/a/IT-Management/University-of-Utah-Trumps-MIT-in-Tech-Startups-823820

[15] U of Utah Repeats as No. 1 University for Startups, Press Release: University of Utah, November 30, 2011 http://finance.yahoo.com/news/u-utah-repeats-no-1-121500599.html

supply and demand factors which may be contributing to market failures in terms of access to venture capital.[16]

California is the strongest in terms of attracting venture capital. According to the CNBC's America's Top States for Business 2011, Massachusetts and California rate 1 and 3 in Technology and Innovation[17] and 2 and 1 in Access to Capital.[18] Companies in California receive 51% of the total venture capital disbursed in the US in 2009, followed by companies in Massachusetts with 11%.[19]

State policy options for improving the business climate include encouraging investment through tax credits and SBIR/STTR awards as well as direct funding to firms through grants and loans for R&D, pension or public funds invested in venture capital funds. One example of this last option is the North Carolina Innovation Fund; a $232.3 million diversified investment partnership sponsored by the North Carolina Retirement Systems.[20]

Research on R&D tax credits has found that the establishment of a state R&D tax credit is effective in stimulating more company R&D expenditures within the state. Empirical results suggest that the presence of R&D tax credit results in 75 to 118 more R&D dollars per capita.[21] Other research concurs but cautions that nearly all of the resulting increase comes at the expense of reduced R&D spending in other states.[22]

Some states use matching grants to attract more SBIR/STTR funding, which can be critical for acquiring early stage capital. Although North Carolina has one of the largest R&D communities in the nation, it ranks behind competing innovation economy states in per capita funding from SBIR and STTR grant programs. To remedy this situation, North Carolina began the One North Carolina Small Business Program in 2006 comprising two programs:

1. The North Carolina SBIR/STTR Phase I Incentive Funds Program to reimburse qualified North Carolina businesses for a portion of the costs incurred in preparing and submitting Phase I Proposals to the Federal SBIR and STTR Programs.
2. The SBIR/STTR Phase I Matching Funds Program to award matching funds to North Carolina businesses who have been awarded a SBIR or STTR Phase I award.

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[16] *Science Technology Industry: Venture Capital: Trends and policy Recommendations*, OECD, no date.

[17] http://www.cnbc.com/id/41666599

[18] http://www.cnbc.com/id/41666608

[19] Science and Engineering Indicators, Chapter 8: State Indicators: 2012 Orange Book, version2, June 2011, p. 8-120

[20] North Carolina Innovation Fund, http://www.ncinnovationfund.com/about_ncif.htm

[21] The Effects of State R&D Tax Credits in Stimulating Private R&D Expenditure: A Cross-State Empirical Analysis, by Yongong Wu, Journal of Policy Analysis and Management, vol. 24, no. 4, 2006, pp. 785-802.

[22] Beggar thy Neighbor? The In-State, Out-of-State, and Aggregate Effects of R&D Tax Credits, by Daniel J. Wilson, Federal Reserve Bank of San Francisco, January 2008.

Since its inception, the Program has awarded 200 matching grants, with a total value of more than $15 million. To date, 114 projects, receiving more than $9 million in State matching funds from the Program have been completed (the others are in progress). This support has helped small businesses to create and retain more than 200 additional jobs most at the managerial, scientific, or technical level, make an additional $14 million in internal capital investments; and leverage more than $38.7 million in external capital investments and $41.8 million in Phase II Federal SBIR/STTR funding. Funding has been steadily declining and as a result, the maximum award for each matching grant has been decreased and the number of incentive grants decreased, limiting early-stage capital to eligible companies. Funding was not appropriated for this program for FY 2012.[23]

Created to strengthen South Carolina's knowledge economy by creating high-wage earning jobs, SC Launch! accelerates the entrepreneurial growth for advanced technology start-up companies by delivering key tools for success, including seed funding, project development funds, and ongoing mentoring and business counseling. Through its university pre-company initiative support program, an SBIR/STTR matching grant program, and funding to start-up companies, SC Launch! is involved in each step of the innovation pipeline. Since its inception in 2006, $50 million in follow-on funding has been secured by SC Launch! Portfolio Companies with 85 companies accepted into the program. It was the 2008 SSTI TBED Winner in the Building Entrepreneurial Capacity Category.[24]

The Emergence of Clusters for Economic Development

Networks or clusters of world-class research universities collocated and partnered with complementary industries that build on regional strengths engender state and local technology–based economic growth. Markusen (1996)[25] has identified four patterns of clusters for economic development. Networked industrial district (NID) clusters such as Silicon Valley and Boston (Route 128) emerge from a combination of factors: strong universities that create new knowledge and technologies through basic research, while simultaneously attracting and creating a high-tech workforce; strong industry that can fund research while using its fruits; venture capital/entrepreneurship; and coordinating bodies that bring together the various participants. The complexity of the development of such clusters requires state policies to be calibrated to specific regional factors. Figure 6 illustrates this model.[26]

[23] http://ncbioscience.net/NCBIO-Advocacy/Factsheets/One%20North%20Carolina%20Small%20Business%20Fund%20Flyer.pdf

[24] http://www.sstiawards.org/2008.html

[25] Markusen, A. 1996. Sticky Places in Slippery Space: A Typology of Industrial Districts. Economic Geography 72:3, pp. 293-313.

[26] Federal-State R&D Cooperation: Improving the Likelihood of Success, PCAST, June 2004, p. 30-32.

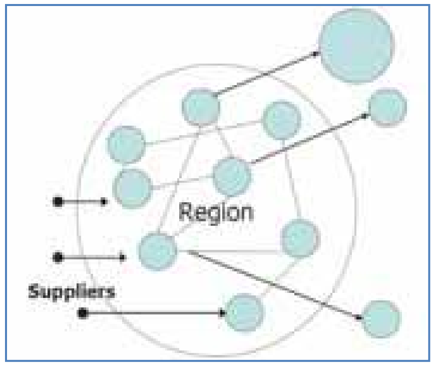

Figure 6. Networked Industrial Clusters

SOURCE: Markusen, A. 1996. "Sticky Places in Slippery Space: A Typology of Industrial Districts." *Economic Geography* 72:3, pp. 293-313.

Most states face significant hurdles in creating a world-class research environment. The mainstay of funding for every state's university research is the Federal government.[27] Federal funds to academia provided $31.6 billion (58%) of the $54.4 billion spent on academic R&D in 2009. Moreover, distribution of Federal research funding is skewed institutionally, geographically, and by discipline.[28] For example, of 711 institutions surveyed, the top 20 in terms of total S&E R&D expenditures accounted for 30% of total academic R&D spending. The institutions constituting the top 5 have remained the same since FY 2004.[29] Table 1 shows the top 20 institutions for FY 2009.

Geographically, in 2008, the 10 states with the largest R&D expenditure levels accounted for about 62% of U.S. R&D expenditures were: California, New Jersey, Texas, Massachusetts, Washington, New York, Maryland, Michigan, Pennsylvania, and Illinois. California alone accounted for 22% of the U.S. total, exceeding the next-highest state, Massachusetts, by almost 4 times. The top 20 states accounted for 84% of the R&D total; the 20 lowest-ranking states, around 5%.[30] The majority of academic R&D historically has been concentrated in the life sciences. Engineering is the next highest field.

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[27] A Governor's Guide to Building State Science and Technology Capacity, National Governors' Association, 2002, p. 15

[28] A Governor's Guide to Building State Science and Technology Capacity, National Governors' Association, 2002, p. 15

[29] Universities Report $55 Billion in Science and Engineering R&D Spending for FY 2009; Redesigned Survey to Launch in 2010 , NSF 10-329 , September 2010

[30] Science and Engineering Indicators, Chapter 8: State Indicators: 2012 Orange Book, version2, June 2011, p 4-16.

Table 1. Top Twenty U.S. Universities by S&E R&D Expenditures

(Millions of current dollars)

Rank	Institution	2007	2008	2009
	All S&E R&D expenditures	49,493	51,934	54,935
	Leading 20 institutions	14,497	15,244	16,424
1	Johns Hopkins U., The[a]	1,554	1,681	1,856
2	U. MI all campuses	809	876	1,007
3	U. WI Madison	841	882	952
4	U. CA, San Francisco	843	885	948
5	U. CA, Los Angeles	823	871	890
6	U. CA, San Diego	799	842	879
7	Duke U.	782	767	805
8	U. WA	757	765	778
9	PA State U. all campuses	652	701	753
10	U. MN all campuses	624	683	741
11	MA Institute of Technology	614	660	736
12	U. PA	648	708	727
13	OH State U. all campuses	720	703	716
14	Stanford U.	688	688	704
15	U. CA, Davis	601	643	682
16	Cornell U. all campuses	642	654	671
17	U. CA, Berkeley	552	592	652
18	U. CO all campuses	528	536	648
19	U. NC Chapel Hill	477	526	646
20	TX A&M U.	544	582	631
	All other institutions	34,996	36,690	38,511

S&E = science and engineering.

SOURCE: National Science Foundation/Division of Science resources Statistics, Survey of research and development Expenditures at Universities and Colleges: FY 2009.

Academic R&D (a combination of Federal, industry, and academic sources) accounts for a little over half of the U.S. basic research, a third of total research, and roughly 10% of all R&D conducted in the U.S. These expenditures have almost doubled in a decade. [31]

The business sector is, however, the largest performer of U.S. R&D. While basic research takes place largely in academia, business R&D accounts for more than half of all U.S. applied research funding and a significant portion, over 80% of all development funding. A high value for the business-performed R&D as a percentage of private-industry output indicator indicates that the businesses within a state are making a large investment in their R&D activities. In 2009, values ranged from 0.14 to 6.08. Business R&D is highly concentrated in a few states:

[31] Science and Engineering Indicators, Chapter 8: State Indicators: 2012 Orange Book, version2, June 2011, p. 8-100

Massachusetts, Connecticut, California, Michigan, New Jersey, Washington, New Hampshire, Colorado, Delaware, Minnesota, and Oregon.[32]

By contrast, state funded R&D is much smaller than academic or business R&D. For example, in 2007 state agency R&D expenditures per $1 million of GDP (an indicator that represents the extent to which R&D plays a role in a state's economy) accounted for less than one-half of 1 percent of total R&D expenditures; most R&D being funded by non-state sources.[33] In 2008, state values for this indicator ranged from 0.44% to 7.39%, indicating large differences in the geographic concentration of R&D activity.[34] States with high rankings on this indicator also tended to rank high on S&E doctorate holders as a share of the workforce, indicating a correlation between the two indicators. Six states appear in both of these "top ten" rankings: California, Connecticut, District of Columbia, Maryland, Massachusetts, and New Mexico.

[32] Science and Engineering Indicators, Chapter 8: State Indicators: 2012 Orange Book, version2, June 2011, p. 8-98.

[33] Science and Engineering Indicators, Chapter 8: State Indicators: 2012 Orange Book, version2, June 2011, p. 8-92.

[34] Science and Engineering Indicators, Chapter 8: State Indicators: 2012 Orange Book, version2, June 2011, p. 8-86